The Assessment of Pacific Island Environmental Vulnerability: A critical study of the development of an Environmental Vulnerability Index by the South Pacific Geoscience Commission.

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Abstract

The interaction between science and policy in the management of the environment in the Pacific region has seen it subject to different interpretations, practices and policies. Importantly, this has exposed the lack of capacity to mitigate environmental degradation in the region, and the need for accurate assessment and monitoring of environmental change.

This thesis examines the conceptions of, and responses to, environmentally framed vulnerability of Pacific Island communities through an examination of one attempt to measure environmental vulnerability in the Pacific Islands by the South Pacific Geoscience Commission (SOPAC). The historical contexts of the science and politics involved in management of the Pacific environment are described, as the development of SOPAC's Environmental Vulnerability Index. Their project has selected and manipulated 47 indicators that do not accurately reflect the role that the environment has in the lives of Pacific Islanders.

It finds that Pacific Island communities remain subject to policies and methodologies implemented by a number of organisations that predominantly involve 'top down' processes that are subsequently imposed on local communities. This gives rise to problems of governance in environmental management that are not necessarily resolved by increases in empirical scientific data, or more sophisticated environmental modelling.

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Finally I would like to thank Bridget Scott, not least for allowing me to dedicate this thesis to our son, Whiti-aua James Scott Lambert, born August 4th, 2001, at 13 minutes past seven pm, weighing in at 7 lb 15 ounces, E 172° 38' S 43° 31'.

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Abbreviations

ADB	Asian Development Bank
BHP	Broken Hill Properties
CCOP/SOPAC	Co-ordinating Committee for Mineral Prospecting in South Pacific Offshore Areas
CIMA	Co-ordinated Investigation of Micronesian Anthropology
CMS	Conservation and Management of Straddling Fish Stocks
CROP	Council of Regional Organisations of the Pacific
CSD	Commission for Sustainable Development
EDI	Environmental Degradation Index
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessments
ENSO	El Nino/Southern Oscillation
ESCAP	Economic and Social Commission for Asia and the Pacific
EVI	Environmental Vulnerability Index
FAO	Food and Agricultural Organisation
FFA	Forum Fisheries Agency
FS	Forum Secretariat
FSM	Federated States of Micronesia
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GIS	Geographic Information Systems
HDI	Human Development Index
IBP	International Biological Programme
IDA	International Development Association
IDNDR	International Decade of Natural Disaster Reduction
IGO	Inter-governmental Organisations
IMF	International Monetary Fund
IRI	Intrinsic Resilience Index
ISDR	International Strategy for Disaster Reduction
ISP	Internet Service Provider
IGY	International Geophysical Year
IUCN	International Union for the Conservation of Nature
LDC	Less Developed Country
MFAT	Ministry of Foreign Affairs and Trade
ML	Magnitude Local

NEMS	National Environment Management Strategies
NGO	Non-governmental Organisation
NOAA	National Oceanic Atmospheric Agency
ODA	Overseas Development Aid
ODS	Ozone Depleting Substances
PICCAP	Pacific Islands Climate Change Assistance Programme
PIPD	Pacific Island Development Programme
PNG	Papua New Guinea
REI	Risk Exposure Index
RS	Remote Sensing
SAP	Structural Adjustment Programme
SIDS	Small Island Developing States
SIWN	Small Island Water Information Network
SOE	State of the Environment
SOPAC	South Pacific Geoscience Commission
SPC	Secretariat of the Pacific Community
SPEC	South Pacific Economic Commission
SPF	South Pacific Forum
SPOCC	South Pacific Organisations Co-ordinating Committee
SPREP	South Pacific Regional Environment Programme
SPTO	South Pacific tourism Organisation
SSGS	SPREP Small Grants Scheme
UNCED	United Commission on the Environment and Development
UNCLOS	United Nations Convention on the Law of the Sea
UNCTAD	United Nations Commission on Trade and Development
UNDESD	United Nations Department of Economic and Social Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNRISD	United Nations Research Institute for Social Development
USP	University of the South Pacific
VEI	Volcanic Explosivity Index
WCED	World Conference on the Environment and Development
WHO	World Health Organisation
WMO	World Meteorological Organisation
WPRO	West Pacific Regional Office [World Health Organisation].

Chapter One: Introduction.

Ascriptions of undevelopment in Pacific Island communities in the post-World War Two era have incorporated a range of historical, economic and social factors in which the environment has had a constant presence but a variously interpreted role. Contemporary interpretations have widened to more centrally include the degradation of Pacific Island environments, prompted by public interest (local, national and foreign) and the insights provided by advances in environmental science. This thesis examines the conceptions of, and responses to, this environmentally framed vulnerability of Pacific Island communities. It does this through an examination of one attempt to measure environmental vulnerability in the Pacific Islands – an Environmental Vulnerability Index developed by the South Pacific Geoscience Commission. Through this case study, this thesis will show how the unique attributes of Pacific Islands and their indigenous inhabitants to various degrees now form the basis for the assessment of their contemporary environmental problems. It will also show that Pacific Island communities remain subject to policies and methodologies implemented by a number of organisations that, while operating at various scales, predominantly involve 'top down' processes which are subsequently imposed on local communities. This gives rise to problems of governance in environmental management that are not necessarily resolved by increases in empirical scientific data, or more sophisticated environmental modelling.

While there are a range of environmental and human factors that characterise the vulnerability of Pacific Island Countries (PICs), a number of common features are evident, namely: geographical isolation, environmental fragility, rapid population growth, limited land resources, high dependence on marine resources, and 'vulnerability' to various environmental phenomena (Overton and Thaman, 1999; UNEP, 1999; Commonwealth Secretariat, 2000). Understanding how contemporary environmental issues affect PICs encompasses interrelated debates along philosophical, epistemological, and political lines, revolving around key questions: what do we know, how do we know it, and what do we do with this knowledge?

These questions will be addressed in this thesis with regard to notions of PIC vulnerability as it is formulated at the interface of science and policy in the Environmental Vulnerability Index developed by the South Pacific Applied Geoscience Commission (SOPAC) - a regional intergovernmental organisation based in Suva, Fiji. The region, with SOPAC membership indicated, is shown in Figure 1. While not all PICs are members of SOPAC, because SOPAC services 16 Pacific nations, the term PIC will be retained with exceptions noted where appropriate.

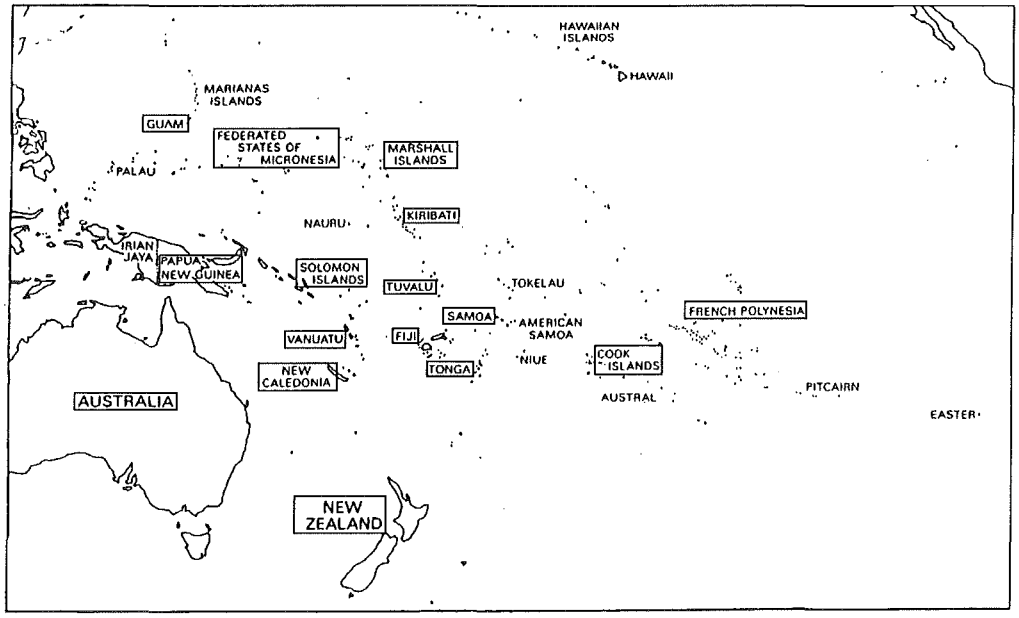

Fig. 1: Pacific Island Countries, SOPAC members indicated in boxes (Overton, 1999, 13).

1.1 An Overview of the Pacific Islands.

While the Pacific Ocean covers approximately 45% of the Earth's surface, its islands cover only 5.8% of the planet's land area and are home to 0.01% of the world's population (UNEP, 1999). These islands have been formed by two geological processes – tectonic activity and volcanism – and one biological process– the growth of coral polyps (Nunn, 1994). Four main types of island can be described, two of which are considered 'high' and of continental or volcanic origin, and two of which are 'low', namely atolls and raised atolls. All the Melanesian islands - Papua New Guinea, the Solomon Islands, Vanuatu, New Caldedonia - are of the high continental type. They are larger, older, geologically more complex, with rugged interiors and a typography that has contributed to separating and maintaining human societies with diverse cultural expressions. Volcanic islands also have mountainous areas, sometimes considerably eroded on older islands, that provide valuable supplies of freshwater. Many of these are surrounded by fringing reef formations. Examples are Rarotonga in the Cook Islands, Kosrae in Micronesia, and Hawaii and Tahiti (Kiste, 1994; Nunn, 1999).

The 'low' coral atoll is the 'classic' Pacific Island, typically comprising of a number of small islands that enclose a lagoon. These islands originated as the fringing reefs around volcanic islands whose central peak has gradually submerged. The Marshall Islands, Kiribati and Tuvalu are comprised entirely of this type of island. The raised atolls are a result of tectonic plate activity that sees an existing island 'pushed' even higher above sea-level, leading to distinctive geomorphology typified by limestone cliffs, and a lack of the resource-rich shallow waters of coral atolls. Nauru and Banaba/Ocean Island are examples. The majority of the Pacific Islands lie in the Southern Hemisphere and within the tropics, their climates strongly influenced by the surrounding maritime environment (Kiste, 1994; Nunn, 1999).

The Pacific Islands were progressively peopled by groups moving eastward from mainland and insular Asia, reaching their furthest extent on Rapanui/Easter Island, and as

recently as 500 years for Wharekura/Chatham Island. (McKinnon, 1997). The 22 countries and territories generally considered belonging to the group of PICs have 7.5 million inhabitants speaking over 2,000 languages; Papua New Guinea, the Solomon Islands and Vanuatu dominate these figures (UNEP, 1999).

The entry of European explorers in the 16th century heralds the beginning of a contemporary Pacific history, acknowledged by the term 'The Spanish Lake' (Spate, 1979). The name signifies both the growing importance of the region to the strategic interests of European powers and a somehow 'smaller space'. While the eastern and western boundaries were the first to be recorded on European maps, the location of the myriad of islands in-between were only slowly fixed, until then remaining 'cartographically floating' (Spate, 1977, 289). Despite maritime voyaging being risky until the 19th century, the world proceeded to 'shrink' and the number and variety of human interactions - with other humans and other environments - increased dramatically. The Pacific Islands were not immune from this increasing interdependence.

The extent of the Pacific Ocean and the isolation of its often-minuscule landmasses resulted in interpretations of them as refuges: islands were both homeland and terrestrial oasis amidst a large though not necessarily malevolent ocean. Paradisal connotations framed much of the early Western thinking on the Pacific Islands as the ocean, its islands and their inhabitants became Muse to an array of artists and explorers (Herman, 1999).

Present day interpretations of these Islands have not been so romantic. While late to achieve the independence that post-WW2 American ideology made inevitable (but contentious), the Pacific Islands have not progressed as hoped, either by Euro-American or nationalist authorities. Subsequent development policies have proven problematic, and a growing 'official' discontent has been expressed that has given rise to a 'doomsday scenario' for these one-time paradigms of paradise (Pacific Islands/Trust Territory Dept. of Resources and Development, 1967; Callick, 1993). What went wrong, with the islands, their inhabitants, with the treatment of both and indeed even the description of their

condition?

A point of historical departure is suggested by Smith (1985) who notes that 1768 was the year in which the Royal Academy of Arts was established and the Royal Society (established 1662) farewelled Cook's first voyage to the 'South Seas.' The Academy was to promote neo-classical theories which required Nature to be recorded in her perfect forms: The Society 'appealed to travellers, virtuosi, and scientists to observe carefully, record accurately, and to experiment' (Smith, 1985, 1). The separation of knowledge from its 'mystical' origins has been a defining characteristic of Western civilisation, generally associated with that period known as the 'Enlightenment' (Weber, 1920; Wilson, 1998). From a limited number of disciplines in the 17th century, science diversified with increasing complexity and evolved into the global phenomenon of international science, exhibiting aspects of corporate activity including the transnational diffusion of personnel and activities (Rasmussen, 1996; Mansell and Paltridge, 1993; Ancarni, 1995). For over two centuries these factors have contributed to how knowledge *in* and *of* the Pacific has been framed.

A legacy of foreign control of resources and institutions in the Pacific has introduced further tension: how is 'scientific research', with its claims of objectivity, to be incorporated into the decision-making process of isolated Pacific Island communities, and who decides how this is to be done? Beginning with Western Samoa in 1962, most Pacific Islands were largely autonomous by the mid-1980's (Chappell, 1999). However, their *development* continued to be influenced by foreign States and/or external organisations (Hau'ofa, 1998; Bertram, 1999). Trade and aid arrangements with other countries and membership of supranational organisations has seen PICs increasingly subject to investigations, programmes and treaties resulting in obligations and international responsibilities.

A number of quantitative measures have been implemented to ascertain the progress of development and other policies. Ranging from bald economic indicators to more wide-

ranging and complex social indicators, the methods have broadened to include environmental issues (Commonwealth Secretariat, 2000). In framing this process, Lasaqa (1973) argued that 'to ignore the local perception is to invite valid methodological criticism, and to reach false conclusions'. Yet indigenous Pacific voices in these assessment processes are notable by their absence and their increasingly plaintive call for inclusion (Barnett, 2000b; Taga, 2001). The concept of 'vulnerability' now seems central to Western ascriptions of Pacific places.

1.2 Previous Work on Pacific Island Vulnerability.

This section will review the concept of vulnerability before discussing those environmental features of islands now implicated in contemporary discourses on PIC vulnerability. The term vulnerability has entered the literature of several disciplines, connotating various degrees of loss, threat and risk. Found in research on hunger and famine, it has ecological as well as socio-political features (Sen, 1981; Adger, 2000; Gillard and Paton, 1999). It is also integral to much contemporary work on hazards and disasters and sustainable development (Hewitt and Burton, 1971; Blaikie *et al.*, 1994; Hewitt, 1997). Yet while data has steadily accrued on the physical characteristics of these phenomena, defining exactly who suffers and from what is problematic (Kasperson *et al.*, 1995; Cutter, 1996).

Cutter (1996) describes three themes in vulnerability studies. The first analyses the communal occupancy of hazardous zones and focuses on exposure to biophysical or technological risk, often in quantified terms measuring magnitude, duration, frequency and so on (Hewitt and Burton, 1971; Johnson *et al.*, 1995). This includes research on technological responses to disaster damage, generally within the 'built' environment (Lawrence, 1981; Mitchell, 1999). While most readily understood as a result of catastrophic circumstances and disasters, when the focus is on *exceptional* events, mitigation tends towards the technological to the detriment of long term solutions

(Blaikie *et al.*, 1994). While fatalities and economic loss, as recorded by governments, aid organisations and the insurance industry, have been the most immediate measure, some 'events' such as drought are difficult to quantify yet may lead to extremely large losses of life and deprivation.

The second theme for vulnerability research revolves around the complex societal response to hazards and disasters that are a fundamental feature of human interactions with their environment (Cutter, 1996). This perspective adopts the position that any response will be framed by the social context and explicitly acknowledges historical, cultural and economic 'root causes' (Blaikie, 1985; Adger, 1999). The development of organised and ad hoc community responses to deal with the ongoing challenges of environmental change provides a complex research field. While this theme is cognisant of the long duration of the underlying processes, it is acknowledged that social vulnerability can change with great rapidity (Watts and Bohle, 1993).

The manifestation of vulnerability as an 'event' will have both a history and geography (Watts and Bohle, 1993; Hinchcliffe and Woodward, 2000). The third theme emphasises the geographical nature of vulnerability and integrates elements of the first two themes, locating the affects within a 'specific areal ... domain' (Cutter, 1996, 533). Geographic space – where are vulnerable people and places located – and social space – who in those places are most vulnerable – is analysed at various scales, including the global (Blaikie and Brookfield, 1987a; Mitchell *et al.*, 1989; Kasperson *et al.*, 1995; Kates, 1997; Smith, 1998; Adger, 2000).

Vulnerability in the contexts outlined above can be defined as the exposure of individuals or groups to 'livelihood stress' resulting from environmental change (Adger, 1999). This vulnerability is sensitive to institutional access, and it changes over time. Certain *events*, of varying rates of onset, can expose inadequate coping mechanisms for individuals, households and communities; this vulnerability has also been shaped by underlying *processes* of varying types. Finally, certain *places* have been assigned vulnerable status.

It is from these concepts that the debate on contemporary island vulnerability originates.

1.2.1 The Vulnerability of Islands: the Pacific region.

While the political geography of the Pacific Region will be broadly described in Chapter Three, the scale of analysis for vulnerability research - although dependent on the type of event and the particular concern - is increasingly occurring at the regional level with important implications for PICs. While acknowledged as somewhat 'fuzzy', the study of regions has been used by Kasperson *et al.* (1995) in their investigation of what they call 'environmental criticality', echoed by Soviet 'red data mapping' which sought to map areas considered vulnerable to environmental hazards (Mather and Sdasyuk, 1991). Although the Kasperson's regions are required to be 'spatially continuous', this thesis will adopt the Pacific *Ocean* as defining a continuous region, a feature acknowledged through various regional memberships, such as the South Pacific Commission (SPC), SOPAC and other organisations. As a region, the Pacific compares poorly with other large-scale island groupings in development terms, as Table 1 shows.

Table 1: Average growth of major regions comprising island states, 1980-90 (% per annum) (Source: UNDP, 1994, 12).

	Pacific Islands	Indian Ocean	Africa-Caribbean
Population	2.1	1.2	2.1
Real GNP	2.1	3.6	5.8
Per capita GNP	0.1	2.4	3.7

The vulnerability of PICs to discrete geophysical phenomena has been explored, with historical narratives often incorporated into assessments of the colonial period (McLean, 1977; Brookfield, 1980). The limited land area and extensive surrounding ocean highlights certain phenomena whose affects are further exacerbated by the predominance of coastal locations for human activity and settlement (Nunn, 1999). Bayliss-Smith *et al.* (1988) argue that the study of islands can profitably draw on research undertaken on rural

development, particularly the limited transport and communication links and associated underdevelopment. Most studies in the Pacific have been cognisant of indigenous social responses to environmental hazards while noting the increased reliance on modern methods of relief, particularly overseas aid (McLean, 1977; Paulsson, 1993; Campbell 1996; Gillard and Paton, 1999).

Most concerns for the vulnerability of the Pacific region have focused on economic issues. It has been noted that relatively high GDP can mask economic vulnerability for PICs and that socio-economic factors frame the impacts and recovery from economic 'volatility' (Betram and Watters, 1985). The effects of political and economic change have impacted unequally on Pacific Island populations, with differences apparent along class, ethnic and gender lines (Finney 1973; Cockerton, 1999). Those economic criteria by which claims to volatility from external sources are considered, revolve around diseconomies of scale, high exposure to global economic volatility, and a narrow export base (Briguglio, 1995). This economic vulnerability has lately been coupled with environmental features. These have been summarised as:

i) limited assimilative capacity
ii) coastal exposure
iii) fragile ecosystems
iv) proneness to natural disasters
v) risks from climate change
vi) exposure to development

(Commonwealth Secretariat, 2000)

The historical impact of environmental change on Pacific Islanders has meant large-scale changes in island settlement as a result of climate and sea-level changes (Nunn, 1999). In this Pacific Islanders have been 'radical transformers' of their environments (Kirch, 1997, 30). This relationship was increasingly complicated by contact with new and foreign cultures as events on the global scale have caused considerable instability in the Pacific. Concerns for PIC instability following European contact has been coeval with that

contact, leading to increasingly coordinated indigenous demands, and often articulated at the regional level (Hau-ofa *et al.*, 1993; University of the South Pacific/ Inst. Pacific Studies, 1986; Howard, 1983). Further, the crises which can accompany environmental degradation or follow severe disasters have been implicated in contemporary socio-economic changes (Barker, 2000).

However, Hau'ofa (1994) argued that debate over any form of PIC vulnerability continues the demeaning treatment of Pacific Islanders at the hands of outsiders. In response, studies might emphasise the strengths and abilities of people and communities to absorb and adapt to negative impacts. Such a 'resilience' discourse in the Pacific includes a reappraisal of customary practises, particularly kinship with its now international networks, and in the process rebutting the labelling of Pacific Islanders as passive victims (Campbell, 1997).

The term resilience is variously used and defined. It has been described as the capacity of a system to absorb disturbance before altering its own structure by changing the variables and processes that control behaviour (Holling *et al.*, 1998). Other definitions refer to the speed of recovery from a disturbance (Adger, 2000). The resilience of an ecological system is contingent on the *functioning* of the system, rather than the stability of any individual populations or the maintenance of a steady state (Ulanowicz, 2000). Ecosystem variations are in some respects predictable by science yet often in ways that are surprising (Holling *et al.*, 1998).

The resilience of *social* systems is related in two ways to the resilience of the ecological systems on which they depend (Adger, 2000). The first is where social systems are dependent on a single ecosystem or limited range of resources, such as those found on small islands. The second concerns the resilience of institutions which is dependent on their historical development, their inclusivity or exclusivity, and their efficacy in satisfying the divergent needs and desires of constituents (Adger, 2000). In this area, different cultural contexts and contrasting world views of different societies will feature

in both institutional adaptions and human-environment interactions (Adger, 2000). Resilience can therefore be seen as an antonym for vulnerability (Campbell, 1997).

1.3 Problem Statement.

Pacific Island environments range from coral atolls of limited extent and resources to large islands with rugged mountainous interiors. These environments were and remain dynamic and occasionally subject to rapid change. Vulnerability to the 'elements' in this context is age-old. For Pacific Islanders it 'came with the territory' as they settled and survived in an environment whose challenges multiplied with the intrusion of European control and influence. As they have been unevenly incorporated into the wider modernising world, an increasing array of factors impact upon the quality of their lives and their resilience in the occupation of their homelands. Of these impacts, those of the environment – particularly climate change - remain the most likely to severely affect the functioning of their communities, although this will be variously experienced by different households and individuals.

The multi-disciplinary nature of vulnerability studies has led to a varied methodology complicated by the lack of consistency in terminology (Torry, 1979; Cutter, 1996). However, mounting concerns over the negative impacts of environmental changes on PICs has led to a broader analysis of island vulnerability. The problems faced by Pacific Island communities with regard to environmental hazards and change are ongoing and immediate. For example, severe social disruption resulted from the effects of El Nino in 1997/98, particularly the associated drought in Papua New Guinea; over two thousand Papua New Guineans were killed when a tsunami devastated their villages on the isolated north-west coast in July, 1997 (Firth, 1999, 415); consecutive cyclones devastated parts of Samoa in 1990 (Cyclone Ofa) and 1991 (Cyclone Val) with losses totalling tens of millions of dollars (Campbell, 1999). The need for informed policies is vital for the future viability of many Pacific Island communities. This will require effective assessment and monitoring of the environment across the Pacific region.

To assist decision-makers in their responses to environmental change, researchers have attempted to better describe vulnerability. Indices in this context represent the culmination of a number of science and policy procedures. As this thesis will demonstrate, the decisions made in this process will have important implications for the interpretation of such a tool.

1.4 Thesis Aim and Format.

This thesis examines conceptions of, and responses to, the environmental vulnerability of Pacific Island communities. It will do this through an examination of one attempt to measure environmental vulnerability in the Pacific Islands – an Environmental Vulnerability Index developed by the South Pacific Geoscience Commission.

In doing this, the thesis will also attempt an analysis of the broader context in which this index has developed. An investigation of the historical antecedents of both scientific and political fields will be required in order to appreciate the role of science across temporal and spatial scales. While this may be ambitious, it is contended that an understanding of the Environmental Vulnerability Index is not possible without a broader realisation of these aspects of Pacific history.

In order to understand the broad details of how knowledge of the environment is constructed, and how this knowledge informs policy and decision making processes, Chapter Two outlines the primary role that science plays in environmental management. In particular, the role of environmental science will be described, as will the place of indigenous Pacific knowledge in mitigating environmental vulnerability concerns. This is necessary in order to appreciate the contested nature of much of what results from the research process, despite claims to the superior insight and objectivity of scientific research. These research results are not separate from the wider society but tend to fulfill

the requirements and desires of political and economic interests. This leads into an examination of the socio-political contexts within which the process of informed environmental management occurs.

Chapter Three provides background to those environmental institutions that have framed human-environment interaction in the Pacific. This requires an overview of traditional, colonial and post-independence contexts that have formulated different responses to environmental issues. In particular the detailed and holistic local knowledge of traditional societies will be contrasted with the exploitation of resources for short-term economic gain that has characterised much of colonial and post-independence development. In practice if not time there are no distinct boundaries between these three historical contexts, and this gives rise to a situation of confused and overlapping jurisdictions and conflicting goals. The management of the Pacific environment thus becomes a contested arena where the interests of Pacific Island communities struggle to be heard. The input of various multilateral and non-governmental organisations in addressing environmental problems in the Pacific therefore becomes a role of great importance.

Chapter Four describes this formal administration of the Pacific region by a diverse collection of organisations, and their role in formulating responses to environmental issues. Large and well-funded United Nations' organisations in particular have played a dominant role in formulating contemporary environmental policies in a range of areas at the global and regional scales. These policies need to be tailored for implementation at the national and local levels, a process that has proved problematic for the Pacific, not least because of a fundamental lack of capacity in Western science and management, as well as a lack of funding. In this context, any large-scale project that seeks to address issues of environmental change in the region must be justified and credible.

Chapter Five describes the development of SOPAC's Environmental Vulnerability Index and details its framework and construction, including wider issues of data availability and funding. The selected indicators and their definitions are described and their specific

applicability to Pacific Islands is discussed. This shows that various subjective decisions have been made relating to the process of constructing this index.

Chapter Six analyses the Environmental Vulnerability Index and its intended application. This shows that the index is a problematic measure that has limited applicability to Pacific Island communities. The claim that the EVI objectively quantifies the environmental vulnerability of Pacific Islands is compromised by its intended uses in the computing of aid allocations, as well as decisions that have minimised the concerns of Pacific Island nations and communities.

In Chapter Seven the thesis is concluded with commentary on the institutional and epistemological continuities and disruptions associated with the increasing breadth and depth of environmental issues in the Pacific region. The issue of vulnerability is revisited to highlight inconsistencies in attempts to deal with the environmental aspects of this vulnerability, and to emphasise the social dimensions of effective and credible mitigation of these concerns.

Chapter Two: Science and the management of vulnerability.

This chapter will outline those aspects of science which inform the analysis of environmental vulnerability in the Pacific. It will begin with an overview of science before examining the relevant areas of environmental science, culminating in an outline on the study of hazards and disasters. The historical development and application of science in the Pacific will be broadly described, as will indigenous Pacific knowledge of the environment. The aim is to outline the role of science – 'Western' and 'indigenous' – in addressing environmental vulnerability issues in the Pacific and thus enable a better interpretation of any index attempting to reflect this for the Pacific region.

2.1 Science

2.1.1 'Western' science.

There are several conceptions of 'science', beginning with applications of know-how to control the environment that implicitly build on craft traditions and best described as advances in technology (Lindberg, 1992). This was summed up by Lord Adrian in a lecture commemorating the 400th anniversary of the birth of Francis Bacon when he noted that 'To make men perfect was no part of Bacon's plan. His humble aim was to make imperfect man comfortable' (in Fisk, 1965, 295). This utility is echoed by philosopher Bertrand Russell (1951) who takes the role back to the early Arab scientists: science would enable us to know things and do things.

Alternatively, science is differentiated from this application to a theoretical pursuit culminating in formal universal laws of behaviour (human and natural), expressed mainly in the language of mathematics. These two positions have been summarised in the term 'research and development' correlating to 'basic' and 'applied' science respectively (Vannevar-Bush, 1945, in Jasanoff and Wynne, 1998).

Yet another view of science is the following of certain procedures for exploring the environment in efforts to prove or disprove theories. After Bacon, many proponents and practitioners of science claimed a special epistemological status: science possesses a privileged way of knowing and justifying one's knowledge (Wilson, 1998). Differences have also been asserted with respect to actual subject matter, concurrent with the teachings of physics, chemistry, and biology, but not astrology, parapsychology and so on that are dismissed as a form of superstitious 'magic' (Wilson, 1998, 253). Finally, 'science' has been decreed as a general norm, with assumptions that it is a rigorous, precise, and objective way of knowing and doing (Lindberg, 1992).

Technology has grown in parallel with science, the two intersecting at what become *a posteriori* important moments in history (Etzkowitz and Webster, 1995; Yearley, 1995). In the process, unpredictable technological spin-offs have stimulated more research and development. This is one of the defining characteristics of Western civilisation. However, whereas science has conventionally been considered useful according to the technological possibilities it has produced, it is increasingly required to understand and mitigate the *consequences* of technology (Branscombe, 1977).

The sheer growth in scientific activity since the Enlightenment made the access and comprehension of the resultant mass of information vital to the scientific enterprise. The computer, as an important common tool in this task, has also enabled 'specialists' to freely transfer between disciplines as diverse as climatology, industrial chemistry, nuclear science, number theory and quantum mechanics (Galison, 1996b). Scientific information is a unique product that now exhibits elements of market and corporate dynamics. Its 'sale' requires conditions of scarcity and control and pressures exist to move what has been a 'public' good into the commercial arena (Goonatalake, 1998; Mansell and Partridge, 1993).

Science and technology form a 'logical continuum' and cannot be definitively separated (Peccei and Mesarovic, 1979). Another aspect of technology is its utilisation as a *tool* of science, providing more accurate observations as instruments have improved and opening

new avenues for research. Although it is generally assumed that this instrumentation removes the biases inherent in human operators and supplies only objective information, the claims of science to be 'value-free' in any way has been itself criticised as an ideological stance (Harvey, 1974).

The historiography and sociology of science have analysed the *activity* of scientific communities instead of simply looking at abstract logic (Merton, 1973). This shows that while science is a contested and competitive arena in both the academic and financial sense, it does take place within an accepted 'cosmopolitan cooperationist ideology' that allows the precise communication of complex observations (Porter and Teich, 1992, 7). However, science as a practise does not and has never existed in a vacuum: it is 'the product of a lengthy social process...the major part of which occurs long after the research is complete' (Ziauddin, 2000, 38). Challenges to the assumptions of dominant scientific discourse have come from, among others, feminist and indigenous commentators who have forced a reappraisal of scientific inquiry, accepting that it is comprised of the 'always-partial, always-finite, always-fraught play of foreground and background, text and context' (Haraway, 1996, 440). These characteristics are evident in the development of a coherent and sophisticated science of the environment, outlined in the following section.

2.1.2 Environmental science

Much of the history of environmental science follows that of the development of science itself, the rapid expansion of which led to many disciplines being drawn together under broad topics of related subject matter (Wilson, 1998). Those disciplines concerned with the physical, chemical and biological aspects of the space in which life exists have been combined to form environmental science. While overlapping with the 'earth' and 'life' sciences, this 'new' field has focused on those processes and changes associated with human activities (Allaby, 1996).

Concerns for the environment have a history as long as recorded human settlement (Darby, 1956). Soil erosion stemming from the growth of cities in pre-Hispanic

civilisations has been posited as a factor in the collapse of those city-states and the relocation of centres of power (Metcalfe, 1989, in Grove, 1995, 18). The degradation of Greek and Roman landscapes appears to have spawned the idealisation of distant, even mythical, lands, especially those located in the Indian subcontinent (Grove, 1995).

The environment in this context comprises the actual biophysical and ecological relationships upon which human survival is dependent. It can be viewed as a number of interconnected processes and phenomena, the identification, measurement and classification of which forms a large part of the activity of environmental scientists (Jackson and Jackson, 1996). In the modern era interactions between humans and their (not always local) environment have multiplied considerably. The term 'ecology' is often applied to this area of study and its etymology, from the Greek *oikos* meaning 'house' and by extension, 'habitat', reveals that the intent of its adherents as nothing less than the 'good housekeeping' of the environment.

This thesis recognises that science is concerned with what Wilson (1998, 65) refers to as a 'free-standing reality variously interpreted by human beings'. This allows a focus on the linkages between these various interpretations (by science communities and other groups), the processes of assessment and monitoring of environments, and the formation of policy from these interpretations. Progress in science has been equated to the accrual of more accurate descriptions and understandings of this 'cognised environment' that enabled scientists to make progressively more accurate claims that they can defend with rational arguments. However, what is identified and measured as 'the environment' does not necessarily correspond to the 'truth' of natural and social systems. This has implications for scientifically-informed assessment of environmental change and prescriptions for its management (see Figure 2).

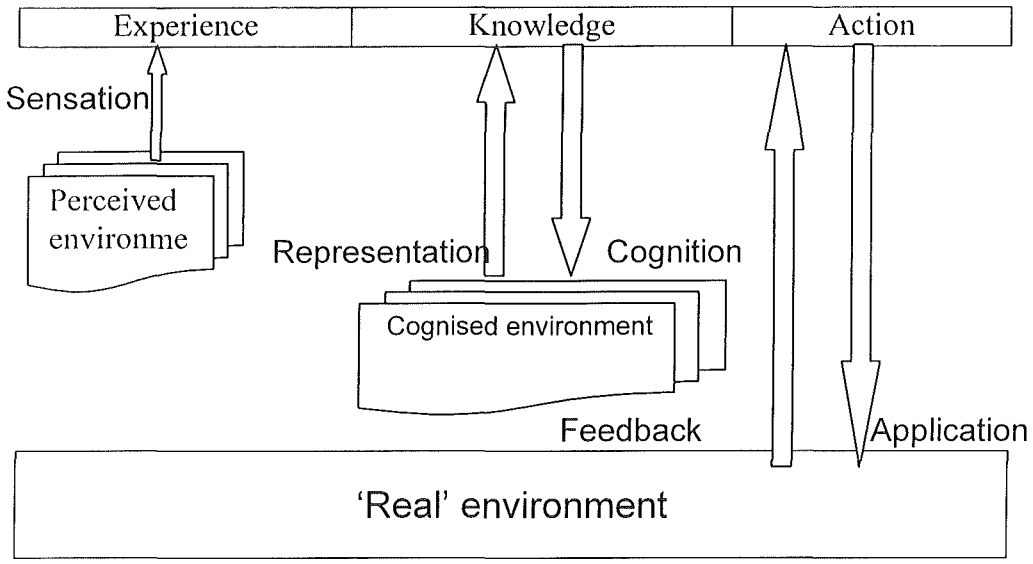

Fig 2: The basis of our knowledge, the cognised environment, is not identical to the 'real' environment upon which human actions are made manifest (after Grano, 1981, 24).

Through colonisation, Western science encountered (and dramatically affected) radically different environments which stimulated a reappraisal of methods. (Grove, 1995). This 'new sensitivity' ironically came about as a result of the ecologically-damaging commercial expansion of the Dutch, English and French East India companies in tropical regions from the mid 18th century, a phenomenon that was particularly noticeable on islands (Grove, 1995, 6). As early as 1791, scientific and lay observations of weather and agriculture in the South Asian tropics were sufficiently co-ordinated to make some of the first speculations about global rather than regional climatic events (Grove, 1998). These findings were made possible because of the organisational ability and reach of the British East India Company, and similar observations and analysis occurred in the Caribbean. Nascent conservationist ideology can be discerned at this time as a result of these evaluations of tropical environments that built on empirical observations and the geographical ventures of various European officials from around 1750 (Grove, 1995). Attempts were made to understand and mitigate the affects of environmental degradation associated with colonial expansion. Such attempts were also informed by the fear of European susceptibility to the effects of a 'hostile' climate within areas predominantly inhabited by indigenous peoples (Grove, 1995).

The modern environmental 'movement' has been a comparatively recent development in political and scientific arenas. It has many similarities to other social movements such as: organisational and funding demands; the motivation of support; and interaction with the media. It differs notably in that to varying degrees it founds its arguments in science (Yearley, 1995). However, while scientific understanding pervades the debate in such areas as climate change, biodiversity, forest management, and fisheries, the holistic character of the environmental movement expresses both scientific credibility and a quasi-spiritual character (Sachs, 1992).

Academic co-operation on environmental science has been encouraged by similarities of subject. For instance, the similarities between Mediterranean-climate ecosystems of California and Chile saw co-operation between the Universities of California and Chile. This partnership became a leading component of the International Biological Program (IBP) which oversaw the emergence of quantitative ecosystem science and the development of (limited) global data sets (Mooney, 1998). Lasting from 1967 to 1974, the programme sought to address a single research gap, that of the productive capacity of the Earth's ecosystems, Earlier co-operative programmes existed. For instance, earth scientists had previously co-operated in 1957-58 for the International Geophysical Year (IGY) (Mooney, 1998). This was followed by International Geophysical Co-operation in 1959 when 12 specially designed and equipped ships from France, Japan, the USSR and the US made at least one trip each to tropical Pacific waters to gather oceanographic data (Nunn, 1999). Environmental science has thus both encouraged and required a global co-operation of science communities, and the Pacific has not been peripheral in these exploits.

2.1.3 Hazards and Disasters

In examining the interaction between human systems and the environment, attention has invariably been drawn to events in which the ability of individuals and communities to cope with environmental change is seriously disrupted or overwhelmed. The relationship between these 'negative impacts' or 'hazards', and the physical phenomena and human

activities that give rise to them is outlined in Figure 3. It is the 'Responses' to these hazards that is of primary concern in this thesis, although aspects of both 'physical event' and 'human-use' systems will be considered.

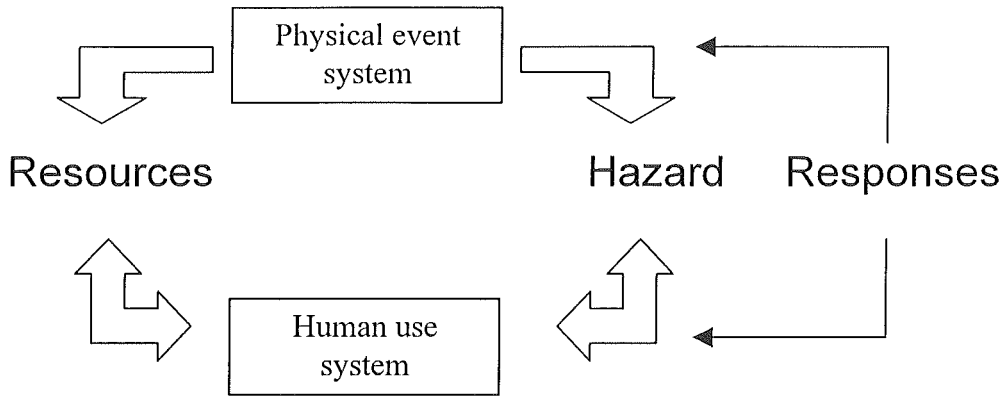

Fig 3: Both hazards and resources result from Human/Environment interaction (Source: Burton, Kates and White, 1993, p32)

The origins and early development of hazards and disaster research reveal a bias towards the natural over the social sciences. In the 1970s research was fragmented between geologists, hydrologists and engineers, with mitigation sought through the prediction of natural events and physical engineering to resist what were considered 'exceptional' events (Smith, 2000). These concepts were highlighted in the formulation of the UN-brokered International Decade for Natural Disaster Reduction (IDNDR) of the 1990s[1]. Stemming from concerns over the recorded toll, both in lives and economic losses, from natural disasters, this was a global programme in which '...the international community...will pay special attention to fostering international co-operation in the field of natural disaster reduction.' (UN General Assembly Resolution 42/169, quoted in Mitchell, 1988, 29). The form this 'co-operation' took was primarily the transfer of advanced technological interventions and assessments, for example satellite warning systems, earthquake predictions and large-scale engineering projects (Mitchell, 1988).

[1] The IDNDR closely followed, and was an extension of, a US initiative that was called the International Decade for Natural Hazard Reduction (IDNHR).

This project was subject to a number of criticisms: the emphasis on scientific solutions; limited local participation; the exclusion of technological hazards; the lack of integration with sustainable development; and the lack of protection of natural resource bases (Mitchell, 1988). Subsequently, the effects of underdevelopment and poverty in the Third World began to be incorporated in research in the 1980s, especially those economic factors that exacerbated geophysical events (Blaikie *et al.*, 1994). Human-induced disasters gained in prominence through specific events such as the Three-Mile Island nuclear accident in the US, and the Bhopal chemical accident in India (Zeigler and Johnson, 1994; Slovic, 1994).

The criticisms noted above were acknowledged by the International Strategy for Disaster Reduction (ISDR) that is to be implemented by an Inter-Agency Task Force chaired by the UN Under-Secretary General for Humanitarian Affairs (Smith, 2000). Its main policy objective is to focus on increasing community-resilience and reducing socio-economic losses through improved public awareness of risk (Smith, 2000). Subsequently the role of science and technology has been clarified, namely to 'disentangle' the relationships between natural processes and human activities so as to provide policy makers with evidence on which to base adaptations to change. It is also accepted that the forecasting of key factors in tropical climates is a priority, and information needs to be expressed in ways that are useful to local decision makers (Smith, 2000).

Despite the assurance with which science has informed environmental issues such as ecosystem functioning and hazard and disaster research, environmental decision-making is not wholly scientific and technical. To a great extent, the social-political context will determine research and policy: values permeate all aspects of this process (Harding, 1998). Dynes (2000) argued that the first intellectual expression of a social science perspective in this area came with a dialogue between Voltaire and Rousseau following the Lisbon earthquake of 1755. Heralding the loss of an 'act of God' as a valid cause of such disasters, their debate can be seen as a corollary to the exclusion of the mystical in the production of knowledge. Yet has this debate ever been resolved? What 'acts of faith'

are now placed in the ability of science communities to solve ongoing, even increasing, human exposure to physical events that disrupt or destroy our communities?

The research field of hazards and disasters may be more complex and diverse but two broad categories can be recognised. The first focuses on the geophysical-triggering of an event, the severity of which is understood to be dependent on both environmental and social factors. The second category considers that disasters are generated from within social systems (Smith, 2000). In summary, scientific and technological development coupled with increasingly coherent concerns over environmental integrity have led to various methods and rationales of examining the environment. The periodic overwhelming of human systems by events involving physical systems have encouraged the ongoing investigation of appropriate responses in which the social context is important but problematic. An historical outline of these developments in the Pacific follows.

2.2 Science in the Pacific

2.2.1 History

Isolation of the 'Pre-contact' era did not prevent the development and maintenance of extensive trade and exchange networks about the Pacific (Petersen, 2000). In the Post-contact era this same 'isolation' did not prevent the spread of epidemics, colonisation or the effects of modern industrial war (Campbell, 1989; Cliff, *et al.*, 2000). In this context early scientific interest was an extension of colonial practise. Apart from playing an obvious part in circumnavigation attempts, the Pacific provided scientists with environments which encouraged research including the coral reefs and the Galapagos Islands upon which Darwin's thinking was so productively stimulated (Stoddart, 1994; Kay, 1994). Observations of the 1769 transit of Venus from Tahiti introduced the dominant figure of Cook and a contingent of scientists to the Pacific (MacKay, 1985). Exploration in this era was increasingly enlivened by the new philosophy and methods sweeping through the European intellectual elite. Following the Enlightenment this pursuit was to be almost automatically coupled with the purposefully prescribed 'rational'

pursuit of knowledge.

Various borders were imposed upon the region, from the Tordesillas Capitulacion of 1494, through a succession of Imperial possessions, colonies and regional alliances, some of which have persisted into the 21st century (Johnson and Valencia, 1991). The ethnic diversity of Melanesia was ignored to a large extent within the colonial borders of German, British and Australian administration. The Mela-, Micro-, and Poly-nesian descriptors are large-scale generalisations based on ethnicity, echoed by theorised biological boundaries (Linnekin and Poyer, 1990; Wallace, 1902). The modern era sees 200 mile Exclusive Economic Zones, a proposed whale sanctuary utilising lines of latitude and longitude, and even separate North and South editions of the revamped Pacific/Islands Business magazine.

Wesley-Smith (1995) describes three rationales for research in the Pacific, beginning with a 'need to know' pragmatism first heralded by the Spanish in the 16th century. Brought to fruition by European interests during the colonial era, it was continued by the US after the Second World War and sought 'influence rather than understanding' (Wesley-Smith 1995, 124). It was exemplified by the U.S. Navy-sponsored study, the Co-ordinated Investigation of Micronesian Anthropology (CIMA), the rationale for which was to aid American administration of Micronesia (Kiste and Marshall, 2000).

The Imperial era was characterised by the belief that the 'aims of science and empire were essentially one and the same' (Gough, 1973, 4). With an intellectual background informed by the Enlightenment, it attracted some of the best young (male) minds of Europe. It was a time in which geographical knowledge was considered of prime importance to the strategic interests of the maritime nation of Great Britain while at the same time being a 'copious source of amusement' (Gough, 1973, 4).

Wesley-Smith's second rationale, that of the laboratory, saw several disciplines utilise the very insularity of islands in the service of individual researchers and theorems. From the biogeography of Alfred Russell Wallace and Charles Darwin, through to the research of

anthropologists Bronislaw Malinowski and Margaret Mead (among others) with their controversial studies of sexuality, islands in the Pacific have been the subjects and locations for scientific activity. Kirch (1997) posits that the often small and always isolated islands of the Pacific are reliable models for the study of global change. And so from palynology (Flenley, 1999) to epidemiology, the study of islands and their inhabitants is supposedly aided, even provoked, by apparently clearly defined boundaries from which a contained field spread away inland.

As the fragmentary knowledge of the Pacific coalesced into a more functional whole, organised scientific research and subsequent application was often in the interest of economic concerns, be they government or private. This framed much of the academic and institutional development of science around Pacific themes as early as 1853 when the California Academy of Sciences was established. Co-operation was most effectively promoted soon after the first Pan-Pacific Science conference, held in Honolulu in 1920. Internationalism in science and a desire that Hawaii should play a leading role in the region were the forces behind the establishment of the Pacific Science Association (Rehbock, 1988). The desire to access resources for commercial gain has provided the impetus for much of this research, especially that dealing with geology and marine biology (Frodin, 1988; Scheiber, 1988; Randolph and Bardach, 1988).

Advances in the science and technology of examining the physical world have driven certain research methods in the Pacific and considerably widened the potential resources available for industrial use (Johnson and Valencia, 1991). The Royal Navy was regularly used as an instrument for conducting scientific research with 190 Admiralty ships deployed on missions of discovery in the 60 year period after 1800 (Gough, 1973, 5). The earliest forays were constrained by simple limitations of the times: ignorance over wind and currents, and the need for fresh food and water, timber and safe havens for repairs. However, by the late 18th century, sea travel was in many respects considerably safer than extended land travel with a well-equipped vessel acting as both mobile fortress and laboratory.

Advances in technology accelerated in the 20th century. Echo-sounding techniques developed in the 1920s aided the mapping of the ocean floor, an area further advanced during the Second World War, and later using sonic profiling to increase this knowledge in the 1950s and 60s (Nunn, 1999). Major research took place in conjunction with nuclear weapon programmes of colonial powers, notably the U.S. and France.

These programmes and their actual and metaphorical 'fall-out' introduce Wesley-Smith's third rationale: 'empowerment' that seeks to reclaim Pacific peoples rights to the production and dissemination of knowledge (1995). This can also be seen in part as a reaction to the early anthropological investigations which saw the region (especially Melanesia) as providing idealised case studies for researchers (Douglas, 1998). This field has been particularly harshly reinterpreted by both 'Western' and indigenous scholars, summarised by one commentator with the accusation that 'anthropologists without Natives are like entomologists without insects' (Trask 1991,162).

2.2.2 Hazards and Disasters in the Pacific.

The traditional response to natural disasters in the Pacific revolved around a high level of self-sufficiency, a major aspect of which was mutual assistance. This took the form of helping out in rebuilding homes and gardens, the provision of emergency food and temporary shelter, and marriages of alliance. Such actions were both intra- and inter-community oriented (Campbell, 1999b).

Whereas traditional Pacific societies broadly conceived of hazards as embedded within the environment, and natural disasters as somehow connected to supernatural will (Ivens, 1927), Western science has historically, as elsewhere and in other fields, attempted to quantify these phenomena and mitigate their effects with technological 'fixes' (Blaikie *et al.*, 1994). Colonial administrations were the first to initiate disaster management comprehensive programmes. In Fiji, the provision of emergency relief in the form of food and building materials first followed a severe cyclone in 1886 (McLean, 1977). Efforts in this area were to increase with each disaster. Financial assistance to the Lau Islands, Fiji,

went from £420 for a 1936 cyclone, to £8,000 for a comparable event 1948, and £11,000 for a similar occurrence in 1958. Total costs of rebuilding from three successive cyclones in 1972-75 was approximately $600,000 (McLean, 1977, 25). Colonial authorities had the benefit of extensive and often detailed records, kept by various plantations, that enabled a detailed overview of disaster effects (McLean, 1977).

The contemporary response is primarily framed by economic concerns, with the Pacific Islands 'lumped' into a broader Asian regional grouping (see, for instance, the Asian Development Bank's *Disaster Mitigation* 1991 publication, or the *Communicable Diseases Bulletin* published by the West Pacific Regional Office). Campbell (1997) warns that the growth of a 'disaster management industry' in the Pacific may be a contributing factor in the creation of vulnerability. External help now dominates emergency relief, and includes training programmes and vulnerability analyses as well as financial assistance. The ability of Pacific Islanders to own programmes aimed at the mitigation of hazards and disasters associated with their environments is diminished.

Losses from large cyclones in the Pacific are steadily increasing. Cyclone Bebe which struck Fiji in 1972, cost that country $20 million; Cyclone Oscar in 1983 cost $80 million; and Cyclone Kina in 1993, $140 million (Campbell, 1997, 57). Modern research into the coupling between ocean and atmospheric processes has revealed the threat of more frequent and intensive cyclones, storm surges, and drought, and the potential for accelerated sea-level rise in the Pacific (Hay and Kaluwin, 1993; Nurse and Sem, 2001). Pacific Island communities are faced with the prospect of increasing vulnerabilities and limited ability to respond.

2.3 A Pacific Science?

Wesley-Smith (1995) considers that Pacific Islanders could claim, per capita, to be the most studied peoples in the world. This research has, until very recently, consistently been framed by Western concepts. Although growing nationalism coupled with the

(almost) gracious withdrawal of the most overt European control has established the training of indigenous scholars, these individuals may be alienated from the main concerns of indigenous society. In this context, the assertion of an 'indigenous science' takes on a greater resonance. How locally produced knowledge informs science and modern environmental management in PICs will be addressed in this section.

Nunn (1999) acknowledged the original explorers of the Pacific as being the first to pursue 'systematic' investigation of the islands, and pre-European knowledge systems have been increasingly explored (Johannes, 1982; Eade, 1992; Roberts, 1998). Previously held views that Pacific cultural matrices arrived complete from Asia have been steadily eroded by contemporary research which now acknowledges that considerable adaptation occurred and specialised knowledge was required to survive in Pacific Island environments (Clarke, 1994a; Siwatibau, 1984). This body of 'traditional' or 'indigenous' knowledge has been defined as that stemming from 'accumulated experience or continuous usage' (Morrison *et al.*, 1994a, pvii). The practitioners and promoters of this knowledge affirm that it is explicitly culturally and geographically located (Roberts, 1998).

Acceptance of indigenous knowledge in the academic world has been achieved within ethnoscience and human ecology, and in some development programmes where it is utilised within farming practice and so-called participatory development (Sillitoe, 1998). The gradual and often grudging acceptance of indigenous knowledge and institutions has also been a feature of creative conservation policy in the developed world, often accompanied by empowerment politics and debate concerning jurisdiction and sovereignty (De Lacy, 1994; Young, 1992; Usher and Bankes, 1994; Berkes, 1998). Such issues are also evident in the Pacific region (Morrison *et al.*, 1994b, 1994c).

There are many commonalties between what are too often paraded as polarities. Both indigenous knowledge and Western science rely on observations of the natural world; they accumulate this information over time, meaning it is 'systematised, stored and transmitted' (Roberts, 1998, 62). The commensurability of these collections of empirical

data have been explicitly noted in biology, particularly taxonomy. Indeed, the assertion of unique, localised knowledge now occurs as an extension of biodiversity, incorporating ethnobiological criteria which expand the resilience concept into the realm of beliefs and practise (Thaman, 2000). Attempts at communicating between these two epistemologies have taken place, but have often foundered on differences of a political or religious nature that can never be fully excluded from any debate on knowledge and its uses.

The diverse technological innovations evident in the exploitation of marine and terrestrial resources across the Pacific reflect both the skill of craftspeople and the detailed understanding of the ecology of their environments. The flora and fauna of individual islands and island groups were categorised, seasonal and diurnal rhythms observed and utilised, and complex systems of resource-use put in place (Johannes, 1981). While no longer necessarily continuous or as comprehensive as it once was, indigenous knowledge has been an invaluable source of data for 'accredited' researchers in the Pacific who are enabled to make scientifically valid statements while others are sidelined (Roberts, 1998).

Although the contribution of indigenous knowledge to improved environmental management is increasingly acknowledged, idealising this can be self-defeating, particularly in times of rapid and extensive change (Sillitoe, 1998). The localised relevance of indigenous knowledge is a significant hindrance to its incorporation into the development process, and the impact of foreign control and influence has led to the fragmentation of traditional societies, limiting the transfer of this type of knowledge in the Pacific. Regardless of these factors, the strength of traditional hierarchies and customary practises in PICs mean indigenous knowledge will feature in many if not most environmental policies in the region. Like 'Western' environmental science, indigenous knowledge seeks to understand the natural world, and both claim a legitimacy that is ultimately connected to jurisdiction and civil standards (Carew-Reid, 1989; Roberts, 1998).

Have Lasaqa's (1973) warnings of indigenous under-representation in the formulation and execution of research been addressed? Sadly the external source of much expertise in the

ranks of Pacific academia remains (Nunn, 1998; Barnett, 2000b). Various reasons have been postulated for this. As early as the 1970s, it was acknowledged that there was little financial incentive for qualified Pacific Islanders to remain in the Islands (Carew-Reid, 1989). Racism, from the overt to the subtle, has also been suggested for the marginalisation of indigenous Pacific researchers (Fry, 1997; Trask, 1991; Taga, 2001). As long as the faces and names are disproportionately foreign or 'expatriate' (that is 'out of' European nations), these accusations will continue to be levelled.

2.4 Science and Decision-making.

2.4.1 Usefulness and problems.

This section will outline the utilisation of science for decision making in general and environmental policy in particular. Habermas (1996) and Lyotard (1984) broadly agree that the legitimacy of knowledge has historically been linked to the legitimacy of political authority: '...the right to decide what is true is not independent of the right to decide what is just...' (Lyotard, 1984, 8). For Habermas, the establishment of a 'humane collective life' is contingent on the inclusion of 'the vulnerable forms of innovation-bearing, reciprocal and unforcedly egalitarian everyday communication.' (Sim, 1998, 268). While the link between knowledge and authority remains, it is continually challenged by the claims of different cultures and social movements with often very distinct world views. How is science to inform contemporary decision making in this context?

Following Newton's description of an underlying movement and order in the physical universe, similar theorising was attempted for social phenomena. This reached a nadir with the often brutal assertions of Social Darwinism which supported, among other things, Imperial discourse and the 'right' of European powers to annex the 'uncivilised' regions of the Earth (Westlake, 1894 in Said, 1995, 207; Winch, 1981; Himmelfarb, 1959). Despite this, it is apparent that science-based recommendations and scientific methodology have increasingly influenced the process of government in the post-World War Two period (Habermas, 1996).

The usefulness of science for decision-makers depends on several variables: time frames, complexity of the problem, compatibility of political and scientific goals, and the presence of alternative approaches (Sarewitz and Pielke, 2000). As the decision-making process is a forward-looking one, the most immediate benefit from scientific activity is the provision of predictive data. Therefore scientific prediction is portrayed as a fundamental determinant of environmental policy and is supported by government and private funding of the study of environmental phenomena (Sarewitz and Pielke, 2000).

However, there are a number of concerns with issues that are important for policy makers yet not be amenable to useful geographic or temporal scales. Implementation may be delayed in anticipation of better information, or information may be manipulated or misused. Attempts to make accurate predictions may divert resources from other responses that could better address concerns. Finally, accurate prediction may not be necessary for some problems and progress in the science of a problem may not correspond to policy requirements and may even sabotage policy goals (Sarewitz and Pielke, 2000).

Inherent uncertainty has reduced the claims of policy makers to have definitive positions on many issues, and the role of governments and the private sector in funding research muddies the objectivity which science values (Peccei and Mesarovic, 1979). This has been noted, along with the concerns listed above, in research on climate change and accelerated sea-level rise (Jasanoff and Wynne, 1998).

The increasing role of science challenges administrative practise and civil service values. Research funders are not necessarily well placed to understand whether recipients are performing, and researchers may have difficulty in proving their productivity or integrity (Gregory, 1982; Guston, 2000). Historically science has been 'implicated' in political causes and the modern State itself has also been not just dismissive of indigenous knowledge but directly oppressive of its own individual scientists and new theories (Galison, 1996a). It is true that governments are increasingly recognising the right of their

citizens to access environmental information. The European Union, for instance, now requires that almost all environmental data held by public agencies is to be available on demand to any citizen (Gunther, 1998). However, conflict is now apparent between a publicly proclaimed epistemology 'cordoned off' from politics but 'secreted away' with restricted lines of communication (Haraway, 1996, 431). In a world where access to information is a defining characteristic of the powerful, access to global scientific information becomes a source of potential conflict.

Regardless of these conflicts, the range of problems for which science assists decision-makers remains considerable and forms a major component of modern environmental management and policy development. The assessment and monitoring of this change, and the communication of the results, becomes an important role for environmental science.

2.4.2 Indicators and Indices: communicating environmental qualities.

This section will describe briefly some of the means by which human interaction with the environment has been assessed and monitored, and how the results have been collated for the purposes of constructing indices to better enable communication of scientific findings to policy makers and the public.

Selecting and recording variables that will act as indicators for a particular environmental policy goal or official concern is to construct a model of a more complex reality (Hammond *et al.*, 1995). The development of an index can take one of two approaches. It can begin with existing collections of data that appear relevant, and seek systematic relationships between the variables; or it can start with an analytical model and proceed from that to select indicators and collect data (Adelman and Morris, 1971).

Indicators are signals that are used to measure, simplify and communicate complex events. A good indicator will have relevancy and use reliable data as well as apply to the appropriate spatial and temporal units (Farrell and Hart, 1998; Campbell, 1999a; Walz, 2000). Ecological significance, quantifiability, data availability, comprehensibility and the relevance to policy dominate selection criteria for environmental indices (Walz,

2000). Figure 4 shows that the collation of an index should result in a 'total measurement system' that involves several interrelated processes (Daniel, 1976, 33).

Assessing and monitoring environmental quality has several purposes. It can suggest or clarify policy, provide insight into the effectiveness of environmental programmes, gauge the impacts of public or private projects, and communicate trends in the state of the environment to officials, the public and decision makers (Craik and Zube, 1976). In this it follows on from similar work on human development indices, the development of which has been called a 'powerful tool' in the promotion of human rights (UNDP, 2000). While the selection of any indicator is governed by relevance and the availability of data, an official index will have 'a research history' which may be politically controversial (Martinez-Allier, 2000, 150).

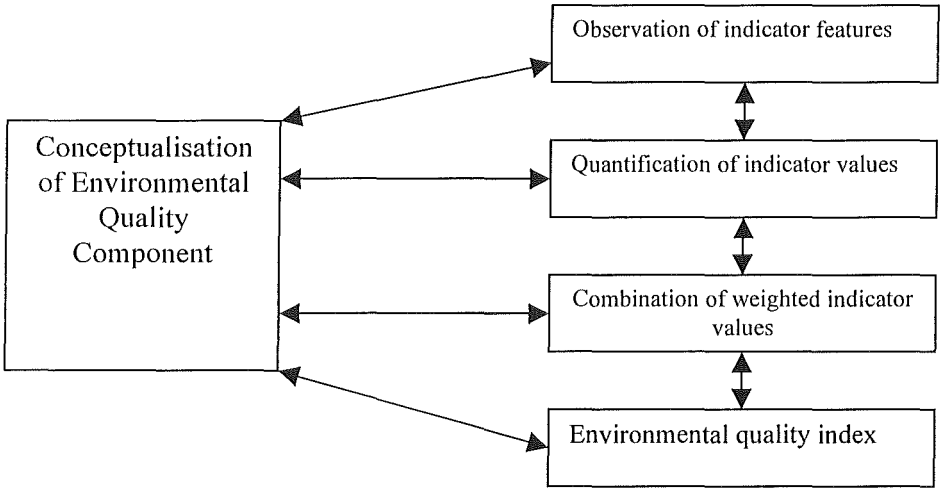

Fig 4: Designing an environmental quality system (from Daniel, 1976, 33).

Modelling environmental processes of any type is difficult. Many changes in the environment are non-linear and discontinuous, a feature not atypical of human-nature interactions. Further, the scale of analysis will depend on the type of problem being addressed, and the particular issue (Kasperson *et al.*, 1995). A considerable quantity of relevant environmental data is still only available in analogue form (Gunther, 1998). While this is primarily historical data it also includes more recent maps, images and documents. Rapid advances in scanning technologies, as well as the emergence of a market for digitising historical data, is changing this situation, and new data are almost

exclusively stored in digital format and availability is mainly a question of logistics and funding (Gunther, 1998).

The concept of 'ecological integrity' is now subject to a wide range of modelling and monitoring efforts (Pimental *et al.*, 2000). Some models focus on a limited range of issues, informed by public, scientific or political concern. The OECD compiled indicators for eight environmental issues, acknowledging that the importance of any single issue would vary by region or country (Hammond *et al.*, 1995). Described as a 'Pressure-State-Response' model, indicators were collated for each issue within a 'cause-effect-social response' framework. Originating as a Canadian government initiative, this model has been adopted by other organisations, including the World Bank (Hammond *et al.*, 1995). Other responses have focused on purely physical components. Haberl (1997) argued that ecological functioning was vulnerable to the appropriation of energy (in the form of biomass) by human systems and analysed this at the community level in Austria. Biomarkers and biomonitors of which the canary in a coal mine is not an analogy but an early example have been proposed as cost-effective and reliable indicators of environmental change (Butterworth *et al.*, 1995).

As the number of indices has multiplied, enthusiasm has grown for simplifying and aggregating attempts. These methods are subject to a range of criticisms based on technical and interpretational factors: results can be manipulated, particularly if they are subject to partisan political use, and inconsistent cultural interpretations are possible as are inconsistencies between indicators that attempted to communicate similar phenomena (Drakakis-Smith, 1997). However, extending this type of modelling to vulnerability issues is problematic. Simplifying the 'causes' of vulnerability to exceptional events that exceed individual or group abilities to cope is to gloss over the complexities of the social arena. Research is advancing into the incorporation of 'livelihood' as a key component of vulnerability, and now attempts to describe access and entitlement to resources (Sen, 1981; Watts and Bohle, 1993; Blaikie *et al.*, 1994).

The aim of environmental indicators is to improve knowledge and aid communication on the state of the environment and the progress of environmental policy, and they must be able to reflect changes over time. Despite the difficulties mentioned above, the utilisation of environmental science in the mitigation of environmental vulnerability is accepted as a means to better inform the decision and policy making process.

2.5 Conclusions

Linkages between authority and knowledge are evident from the beginnings of human history. The development of a strong methodology for observing and interpreting the physical features of the universe that began in 17th Europe was transposed to other areas, and with more in mind than simple description. The historical linkages that are evident between Empire, commerce and science were to be replicated in the Pacific region. Science is now a diverse field, international in extent, with strongly held claims to objectively represent aspects of the environment.

Concerns for the environment, particularly as it is affected by human actions and strategies, was one feature of colonial expansion that was coupled with rigorous analytical thinking. Policies attempted to secure future commercial and social security, albeit for the ultimate benefit of colonists and metropole interests. The response to disasters affecting the Pacific Islands now automatically include a formal international response, as well as ongoing mitigation efforts.

The development of a science of the *environment* that focuses on human/nature interactions has seen an increase in the coherence and sophistication in environmental analysis and modelling, albeit with considerable uncertainties, especially at the global and regional scales. Like all science, it operates within a socio-political context which influences academic and institutional activity. The growing collections of valuable environmental data are not necessarily freely available to all who would benefit from them.

Science has two important roles in contemporary environmental policy formation, namely the prediction of environmental change and the unravelling of anthropogenic and natural factors in this change. The vast and complex output of scientific activity has meant the communication of scientific information and understanding, whether for utilisation by policy makers or other decision makers, or for the benefit of ordinary citizens, is now an important function of scientific communities.

Science as an extension of colonial practise in the Pacific has been only lately and minimally challenged by indigenous scientists trained within the 'orthodox' Western system, and also by the assertion of indigenous knowledge systems whose value lies in both unifying local communities and providing accurate micro-scale environmental data. Despite this, the concepts, personnel and policies remain external to many Pacific Islanders. How their environments have been conceived, assessed, monitored and subject to jurisdiction will be discussed in Chapter Three.

Chapter Three: Environmental management in the Pacific.

The previous chapter has demonstrated how 'Western' science has a dominant role in the assessment and management of contemporary environmental vulnerability. This chapter considers the role of institutions in managing Pacific Island environments. It outlines traditional, colonial and post-independence approaches to environmental management. At the same time, this chapter will also outline development strategies in the Pacific Islands, review efforts to monitor their results, and outline the progress. It will finish with an brief overview of methodology used for the evaluation of PICs and their inhabitants. The aim is to describe important aspects of the context that has influenced the latest efforts to assess Pacific Island environmental vulnerability.

3.1 Environmental institutions: traditional and colonial

3.1.1 Traditional management systems.

The term 'traditional', when used to describe human activity, implies a certain invariance in social institutions. It is generally applied to those social practices that are formalised and communicated between successive generations because of their educative value (Hobsbawm and Ranger, 1983). Most Pacific cultures described as 'traditional' by anthropologists are actually neo-traditional: Pacific Islanders have always been willing and able to assimilate exogenous factors in constructing their cultures (Sahlins, 2000). 'Tradition' is integral to the evolution and actions of environmental institutions, defined for the purposes of this thesis as the predominant rules and standardised behaviours through which human societies interact with their environment. Despite its problematic use (see Linnekin and Poyer, 1990), the term will be retained for this thesis.

Pacific societies and cultures have historically had a detailed intimacy and familiarity with their environments (Mark, 1976; Pernetta and Hill, 1984; Roberts, 1998; Marsh, 1999). This has been clearly expressed in the complex classification systems that evolved for describing the flora and fauna. *Kalam* speakers in the south-west province of Madang,

PNG, distinguish between about 400 vertebrate and 120 invertebrate categories according to a number of characteristics including: morphological details, their value as prey, the best capture methods, and what is considered unclean or dangerous to people at different stages of life, (Pawley, 1999). Micro-environmental zones are also named, revealing a great understanding of processes and relationships (Pawley, 1999).

Many Pacific Island communities expressed considerable psychological attachment as evident in myths and rituals whereby animals and plants were assigned roles and credited with a range of abilities (Thompson, 1949; Lindstrom, 1999). This includes animals acting as 'messengers'. Skilled fisherman of Palau could identify not only the location of a school of fish but also the species, whether or not they were feeding (and therefore likely to take a lure), and the type of fish they are feeding on by observing the activity of accompanying flocks of birds (Johannes, 1981).

Other species and landscape features were incorporated into genealogy, often with great complexity and ingenuity as comprehensive narratives were constructed in which settlement and continued occupation of a place was given meaning and legitimacy (Pawley, 1999). Some Banaban genealogies begin with 'birdlike' ancestors (Maude and Maude, 1994), and across Melanesia stories are told of snake relatives who reward kindness and avenge maltreatment (Poignant, 1967). The Bogarali clan of PNG still teach their children the names of streams and other landscape features a century after the Bogarali were defeated and dispersed (Ballard, 1997).

The role of land and water in Pacific cultures has been examined in detail by many studies across various disciplines. It has been described, and is generally accepted rhetorically, as being inseparable from the people (Crocombe and Meleisea, 1994; Ward and Kingdon, 1995; Burton-Bradley, 1974; Ravuvu, 1983). The Chamorros of the Marianna Islands call themselves *Taotao tano*, 'people of the land', while the atoll inhabitants from the central Caroline Islands distinguish themselves from those who occupy the high islands as *Re metua*, 'people of the sea' (Diaz and Kauanui, 2001, 319).

The allocation of access rights to resources was central to the functioning of all communities. The Hawaiians refer to land as *''aina'*, 'that which feeds', and the word and concept is repeated throughout Polynesia (Diaz and Kauanui, 2001, 320). Crocombe (1964) argued that genealogical title was inconceivable apart from the lands associated with it, and this 'evidence' - the ability to name and 'narrate' landscape features, as well as the buried remains of ancestors - was placed and accepted before the Cook Islands Land Court. Although land tenure arrangements across the Pacific are diverse, traditional institutions conserved resources by limiting access to those with acknowledged rights, and control was intimately bound with social institutions that viewed resource use as part of the management of entire landscapes (Thaman, 1993).

Most islands have not suffered from the type or degree of land degradation observed historically in continental areas of the world. There is evidence of problems, primarily deforestation, where population densities reached high levels or where certain practises were destructive. One case, that of Rapa Nui/Easter Island, a Polynesian 'outpost' under Chilean possession that is 3,000 miles from South America, has been near mythologised as an example of the degree of over-exploitation of Pacific environments. Although climate change has also been advanced as an explanation for the forest changes, continuous cover is evident from around 35,000 years Before Present (B.P.) to just c. 1200 B.P., surviving earlier climatic fluctuations (Butler and Flenley, 1999). The unsustainable use of resources by Polynesian settlers on Rapa Nui has been posited as the primary cause for a drastic decline in human population and collapse of an entire culture (Bahn and Flenley, 1992). Prior to European contact, the human population may have peaked at 12,000; by 1877 only 110 remained (McCall, 2000, 84). Indigenous activities were not the sole factor in the decline. Following civil war and the over-exploitation of resources, there remains the effects of climate change, disease and the deprivations of the slave-trade in the Pacific, known as 'blackbirding', that saw numbers of young people transported around the Pacific in efforts to supply plantation and mining labour markets. in the 1860s (McCall, 2000).

Changes to soil and water resources can occur without any human influence, rapidly in some environments. For such processes to be termed 'degradation', human activity has to be explicitly involved, utilising or otherwise interacting with physical systems (Blaikie and Brookfield, 1987b). When eroded materials are deposited as sediment, an initial loss can occur, particularly when coral reefs are adjacent to an affected area. The 'positive' impacts from such change can be centuries in the making and still require considerable human labour. Tikopia, a small outlier island in the Solomons group inhabited by Polynesians, experienced human-induced soil movement that saw the island's lowland area increase from 3.3 km^2 to 4.6 km^2. Beginning a 1,000 years ago, this 'new' land became Tikopia's most intensive agricultural land (Spriggs, 1981, in Clarke, 1986). What was initially the degradation of one resource becomes, by innovation, an opportunity to exploit another.

Societal responses to environmental change and new technologies could also be direct and rapid. The introduction of the sweet potato into the highlands of Papua New Guinea 300 years ago altered horticultural practises, leading to intensification, expansion and innovation. Increasing population pressures and a highly competitive social system that relied on the increased production combined to effect long-term degradation of soils. Vulnerability to these impacts was spread unevenly through affected communities, with pressure falling on the weaker groups, particularly women and children, to maintain production in the context of declining yields (Allen and Crittendon, 1987).

Marine resources have had similarly dynamic influences in traditional societies of the Pacific, particularly Polynesian and Micronesian societies. Tenure systems for reefs and lagoon access were not seen as separate from terrestrial tenure systems but rather as an extension and continuation of the same system. These rights were 'multiple, conditional and negotiable' and were generally exercised through groups (Crocombe, 1999, 208). Extensive marine resources, where they existed, allowed wider communal access. However, for smaller land masses, or islands where marine resources were poor, more complex allocation occurred, with access tightly defined through descent groups, families or even individuals (Crocombe, 1999).

The complex categorisation of ecological systems by Pacific Islanders was evident in the management of resources when community access meant the risk of conflict and exploitation. There were surface, sub-surface and bottom access rights, as well as species specific quotas (Johannes, 1981). Seasonal restrictions were commonplace, generally designed to protect food sources at sensitive periods of their life cycles, most obviously for spawning (Baines, 1984). Other constraints or *tabu* were applied to certain social groups or classes, or were applied to mark an important event to boost stocks for a delayed celebration. The death of a chief in Ucunivanua, Fiji, meant a ban on the use of sea areas, the lifting of which depends on the maturity of *dalo* crops planted after the burial ceremony. This could take up to a year, and the practice has continued through to modern times (Vunisa, 1994).

Excessive exploitation was generally discouraged and often actively prevented. Restrictions to certain areas were easily and quickly imposed by those with the authority to do so, and instructions were unproblematic in oral cultures (Johannes, 1981; Olsen, 2001). Certain methods of harvest were banned or discouraged, usually for techniques that were *too* efficient or indiscriminate, and surplus kills were generally regarded as wasteful and even anti-social (Eaton, 1988),

Many islands, particularly in Polynesia, lent themselves to a radial division for tenure purposes, with each wedge-shaped parcel containing a similar array of resources. In Tahiti, each valley system included a coastal strip at the valley's opening, the associated lagoon, reef and offshore resources, with the terrestrial segment representative of the islands' array of major resources (Finney, 1973). The physical characteristics of such watershed divisions meant that the ecological effects of one groups' actions posed little threat to any other group. Elongated islands such as those found in atoll groups were more likely to be divided by transverse boundaries (King, 1999). Inhabitants of smaller or closely scattered islands often required a number of scattered parcels of land and sea for viable communities, allowing access to at least one productive area at any one time (Denoon *et al.*, 1997).

Concerns for social harmony are explicit in many traditional practices. Boundaries between different groups and their resources could be quite hazy; markers, if used, were simple and readily recognised. Trees, rocks, and other landscape features were all regularly used, as precise and continuous demarcation was not generally required. On Mitiaro Island in the Cooks group, there is a strong aversion to physical partitioning as it suggests a distrust of neighbours (Brooks, 1997). Where complex boundaries existed, 'specialists' were often required to adjudicate disputes. Their remarkable recall was, on occasion, biased, and this imparted a socially and politically useful degree of flexibility (Crocombe, 1999).

Pacific Island communities have been grouped together in the past by migration, trade and exchange networks. Melanesian societies practised ritualised exchange that could be intensively competitive: 'gifts' imposed strict obligations. Missionaries on Murua Island in 1850 observed famished Muruans greeting their trading partners with a feast (Denoon, *et al.*, 1997). In one of the more complex examples, a Micronesian 'empire' centred on Yap, now a member of the Federated States of Micronesia, saw regular tribute, trade and exchange rituals enacted (Petersen, 2000). The assistance of neighbouring islands in this manner not only played an important part in coping with environmental hazards and recurring natural disasters, but also widened the supply of mates during times of demographic upheaval, and supplied prestige items for elites (Thomas, 1999).

Islanders repeated the pattern of many pioneer settlers in that they actively modified and regularly degraded their environments (Nunn, 1994; Blaikie and Brookfield, 1987a; Clarke, 1994a). Some islands were 'recorded' within oral culture as being hazardous and inhospitable. Ivens (1927, 158) notes the following song of the southern Malaitans pertaining to a nearby island:

> Uki with its oily yam mash
> Its flying sands
> Uki of the sandy shore
> Disappearing in the coconuts

Net fish with yells
Uki where yam sets die.

Richmond (1977, in McLean, 1980, 160) notes the lack of reference to tsunamis in traditional legends or dances, and considers this due to Pacific Islanders interpreting any large waves as simply the product of distant storms. It can be assumed that the coping mechanisms for such events, of which tropical cyclones were the most typical, utilised a number of practices. The use of resilient crops was important, particularly the yam (*Dioscorea* spp.) which may sustain severe damage to stems and leaves while the edible root remains minimally affected (Campbell, 1990). The growing of a diverse range of agricultural products meant that the chances of all species being lost in any one location was reduced (Thaman, 1994). Campbell's study of the Banks Islands in Vanuatu showed that the islands not only varied in terms of their staple crop but were also sufficiently geographically dispersed so that it was unlikely all the islands would be equally affected (Campbell 1990). The tropical rainforest with its diversity of species is resistant to wind damage, and those communities reliant on such a resource would undoubtedly find some sustenance within its bounds. The knowledge of 'famine foods' such as the Sago Palm (*Metroxylon* spp.) – the use of which was normally too time-consuming - meant an emergency supply of food could be gathered. Food storage techniques such as drying and fermenting allowed a range of products to be preserved (Campbell, 1990). Finally, the maintenance of inter-island networks allowed exchange and support, often from extended kinship groups, and always with the assumption that such arrangements were reciprocal.

Internecine conflicts are recorded in the histories of many Pacific Island communities as the motivation for groups to emigrate and seek new lands. Several Polynesian legends tell of disputes that result in one group departing and settling another island (Orbell, 1995). The process of indigenous settlement across the Pacific involved the use of power and knowledge in competition over resources and places, and the 'binding' of social identity to specific locations - expressed through traditional songs, legends, constructed genealogy and the fact of continued survival - was the result of successful settlement (Thomas, 2001).

The resilience of traditional communities world-wide has been a function of similar characteristics, namely the strength of kinship ties, the size and mobility of the labour force, the reserves of food supplies or the ability to 'bargain' for relief (Torry, 1979). When these arrangements extended to other islands, it allowed the utilisation of resources beyond the immediate control of communities. Whether such customs as outlined above amounted to the 'conservation' of resources, as commonly perceived by Western commentators, or were inseparably intertwined with the pragmatic protection of short-term interests of certain groups is debatable. Certain practices, for instance infanticide (Veitayaki, 1997), would now be viewed as barbaric by contemporary societies. However, the practise of socially controlled resource-use and mutual assistance between communities was well established prior to colonisation (Pernetta and Hill, 1984; Pawley, 1999).

3.1.2 Management after Colonisation.

If traditional Pacific societies exhibited a range of social and cultural arrangements for environmental management and the control of resources, what were the effects on this arrangement from colonisation and the associated intrusion of radically different rules and ideologies? While not necessarily enjoying territorial completeness – as elsewhere, authority tended to dissipate with distance –colonisation did attempt to impose a unified policies and ideologies that altered traditional practice. Common features were evident in how land, boundaries, minorities, mixed-race groups and women were treated (Blaikie, 1985; Johnston and Valencia, 1991; Stoler, 1995; Cockerton, 1999).

A Western 'awareness' of the Pacific can be accurately dated and is comparatively well documented. The region was first described in an account of the 1519-22 voyage of Magellan when, blessed with fine weather, the voyage registered the 'South Seas' in European cartography for the first time (Spate, 1977). The publishing of travel diaries, accounts and official records always accompanied European exploration. These accounts tended to idealise certain aspects of Pacific Islands, such as the beauty and nobility of

some islanders and their bucolic lifestyles (notably Tahiti), and demonise others, particularly the 'savage' Melanesian societies (Herman, 1999).

The corresponding indigenous awareness of the 'West' grew slowly. Initial contacts were few and often limited, and many European missions were little more than enclaves subject to regular setbacks and occasionally tragic endings. The first attempt at settlement, by a Spanish expedition led by de Mendana on Santa Cruz Island in the Solomon Islands, 1595, was wracked by illness, insubordination and hostility from the indigenous inhabitants, and resulted in the death of de Mendana and many of his companions (Dodge, 1976).

For indigenous peoples, first contact could be dramatic even when indirect. De Mendana's expedition killed 200 Marquesans en route to Santa Cruz, many for little more than sadistic target practice (Dodge, 1976, 18). Despite the threat of violence – and it was replicated across the Pacific even by such 'progressive' figures as Cook – Pacific Islanders continued to attempt to placate European parties. Pearson (1969) describes a pattern that saw the initial welcome ended by a breach of custom or misunderstanding, followed by violence and defeat for the inhabitants that led to appeasement in the form of hospitality and the proffering of young women. Herman (1999) considers this forced 'promiscuity' to be the origins of the 'eroticization' of the South Seas, to which I would add the fears of a 'simmering' violence also continue to be held by Europeans.

Infectious diseases, introduced by Europeans, ravaged many Pacific Island communities. Cliff *et al.* (2000) show that while the number of infectious diseases is inversely correlated to latitude (consistent with species-range biodiversity models), the number is generally less for islands than continental areas (an effect of isolation on critical community size). Despite this, large losses resulted when diseases such as measles, cholera, influenza and others arrived on previously unexposed communities. The populations of Fiji, Samoa and Tonga were exposed to the global influenza epidemic of 1918-1919 by carriers on a ship from Auckland. Around 10% of the Samoan and Tongan populations are thought to have died (Cliff *et al.*, 2000, 139).

By 1900 every island in the Pacific had come under foreign control through processes of conquest, cession or destabilisation (Chappell, 1999). The continued intrusion of colonial ideology and practise led to the introduction of Christianity, a cash economy and Western material goods. Historically, colonial forces 'authorised' and supported certain traditional institutions that could facilitate their control and administration of colonised societies, often to the detriment of evolving practise or viable alternatives. The successful establishment of new practices and beliefs required the co-operation of these leaders (Howe *et al.*, 1994; Dodge, 1976; Ravuvu, 1983; Friesen, 1986). In the 1850s, German authorities in Micronesia achieved their aim of developing a copra trade by working through traditional chiefs who encouraged their people to extend their plantings of coconut trees (Kiste, 1968). Disputes, when they arose, were likewise mediated through indigenous leaders. When chiefs on Wallis and Futuna (several small volcanic islands west of Samoa and north-east of Fiji) complained of their people being exploited as labourers in the 1960s, French authorities placated the chiefs with personal indemnity (Likuvalu, 1988, in Pollock and Crocombe, 1988).

Colonial development focused primarily on commercial agriculture, commonly based on extensive mono-cultural plantings. Foreign companies, often with government co-operation, implemented large-scale plantations, primarily of coconuts, sugar and bananas. The introduction of new technologies for resource extraction further increased the threats to forest cover and biodiversity (Blaikie and Brookfield, 1987d). As a result forest degradation accelerated rapidly in coastal and lowland areas, and farming practice and land tenure arrangements were altered as more extensive cropping was encouraged by colonial policy and the increasing indigenous involvement with the growing cash economy (Blaikie and Brookfield, 1987d).

Marine rights were often the first to be curtailed by colonial powers, with most administrations declaring all areas below the high tide government property and equally open to use for all (Crocombe, 1999). Even Tonga, the only Pacific island never subject to direct colonial rule, saw the government assume marine ownership rights in 1887

(Adams, 1998).[1] Although reef and lagoon resources were not heavily targeted by colonial industries, the settlement of coastal areas by Europeans and migrants led to increased stresses on inshore marine environments. The availability of better technology enabled wider and more intensive use of marine resources. Motor boats could access more distant fishing areas, and nylon nets and spearguns drastically increased potential catches (Crocombe, 1999).

Large-scale labour movements were encouraged by colonial authorities and commercial interests, often with the connivance of unscrupulous middlemen (Spate, 1983). In the 1860s, Peruvian 'blackbirders' seized over 3,000 Pacific Islanders to work in mines and plantations (Chappell, 1999, 137). Between the end of the 19th century and WWII, circular migration connected with plantation employment was the main form of indigenous Pacific mobility (Rapaport, 1999).

Where indigenous labour could not be secured, indentured workers led to significant ethnic minorities becoming established. Indian workers in the sugar plantations of Fiji are the best known example of this, their numbers reaching over 50% of the total population in the years leading up to a rhetorically racially-motivated coup in 1987 (another coup occurred in 2000). Chinese 'sojourners' were a small but often important minority, although their numbers never threatened indigenous control. Although some of this migration was temporary or circular, subsequent changes in social structure have permanently altered the traditional institutions of both migrant and indigenous populations (Doumenge, 1999).

Involvement in the cash-economy was, for many Pacific Islanders, very limited. On Tuvalu at the end of the 19th century, it amounted to supplying traders with copra and making contributions to the London Missionary Society (Munro, 1990). The cash-economy has not simply replaced traditional subsistence activities. In Papua New Guinea, the introduction of colonial commerce in Papua New Guinea enabled an alternative means for Highlander males to attain status (Sahlins, 2000). Further, from the 1960s it

[1] Tonga was a British Protectorate from 1900 until 1970.

has been observed that inter-clan ceremonial exchange has actually flourished, and money 'has become the means, rather than the antithesis, of community' (Sahlins, 2000, 53).

The effect of such colonial policies as were enacted in the areas of employment and new economic opportunities and obligations was to encourage the movement of people from rural areas to urban settlements, and from outer islands to provincial and national power bases (Connell and Lea, 1999). Although this phenomenon was evident throughout the colonisation period, World War II increased the rate for many communities. American bases on Guadacanal in the Solomon Islands during World War Two facilitated rapid growth in the urbanisation of Honiara, a process begun by the British colonial presence. This phenomenon had an ethnic component, with Malaitans being favoured over local Guadacanal people for employment. In the 1970s, young men were still migrating to Honiara, seeking employment or the opportunity of starting a small business (Frazer, in Denoon *et al.*, 1997).

Such processes altered but did not necessarily eradicate traditional authority. For example, while colonial authorities in the Cook Islands nucleated three previously dispersed villages on Mitiaro, the adherence by inhabitants to genealogically-based organisation persisted, and was expressed in the spatial organisation of the 'new' village (Brooks, 1997).

Colonial policies strengthened patriarchal control in Pacific societies and altered the traditional division of labour (Cockerton, 1999). Previously men and women had shared many tasks, such as child rearing. There were also traditionally assigned roles. In Tonga, women had produced bark cloth and coconut oil, fished the lagoons, and cooked special, chiefly, dishes. The men farmed, fished outside the lagoons and built canoes (Rennie, 1991). After colonisation, men became the main participants in the new cash economy, despite the considerable contribution of women in subsistence agriculture and fishing activities, and too often European gender discrimination practices were followed (Cockerton, 1999).

Traditional co-operative resilience has been affected by the introduction of a cash economy. The remittances of migrant workers who sought employment away from their home villages, primarily on plantations, became a valued if sometimes irregular, asset for some families and villages (Munro, 1990). Another, more problematic, coping mechanism also developed, that of rural credit. While it has not always had the desired and intended effect of increasing rural productivity, it has added to the methods by which Pacific Islanders interact with their environments and attempt to maintain the viability of their communities (Brookfield, 1971).

The Second World War and its aftermath further incorporated PICs into the global economic system and raised the profile of the region dramatically in the minds of Pacific Rim policy elites (Thompson, 1994). At the end of WWII, the North Pacific was primarily under U.S. control, the South the concern of Britain (with 'Anglo-Saxon' support from Australia and New Zealand) and to a lesser degree France (Dalton, 1992). The physical isolation of islands and island groups ensured a certain degree of autonomy from the more overt colonial practices, leading to descriptions of 'benign neglect' on the part of European powers in the region. After World War Two this was further diluted as interdependence became established in an increasingly geopolitically and strategically important region of the globe (Thompson 1994).

Resistance to colonial control took a variety of forms, from violent rebellion to feigned indifference. In 1910, inhabitants of Sokeh district in Pohnpei (now a member of the Federated States of Micronesia) resorted to an ultimately futile armed struggle against a brutal German administration: protagonists were executed and their families exiled (Chappell, 1999). New Zealand-controlled Samoa experienced concerted protest by the non-violent Mau movement that culminated in a massacre of peaceful protesters in 1929 (Campbell, 1989). Other protests took the form of alternative churches and messianic movements. The well-known, if generally misunderstood, 'cargo' cults of Melanesia were led by local prophets who combined indigenous and Christian beliefs and promised change and material rewards (Chappell, 1999).

The implications of colonisation for indigenous knowledge and management of environments were serious. Fragmentation occurred as a result of several factors, principally the spread of a cash-based consumer society, explicit colonial policies concerning education and health services, restricted and constrained political representation, and over-whelming economic interests that were dominated by European governments and private businesses. Colonised peoples were never passive and the process was always a negotiated one (Leckie 1983; Jacobs 1996). Christianity in the Pacific became a syncretic religion in many ways, combining traditional beliefs with the new religion (Linnekin, 1997). It was a means by which chiefs continued their rivalries as missionaries became unwittingly involved in local conflicts. An agreement by a high ranking Pohnpei chief to provide land and protection to a Protestant missionary in 1852 was, in Pohnpei culture, an expression of 'ownership' by that chief. The chief benefitted from both cultural and material 'baggage' which were utilised in factional power play with a rival on another island. No converts were won over in the ten years the mission operated (Linnekin, 1997).

The contradictions inherent in a colonial ideology that was based on an exploitative attitude to people and resources, and a self-anointed benevolence were to be observed in conservation policy. Colonial administrations often initiated responses to resource depletion yet ignored or were contemptuous of indigenous 'institutional memory' in this field (Blaikie and Brookfield, 1987c). Any policies with environmental designs were generally integrated within the wider rationale of commercial agriculture, and policies formulated to protect soil, water or forest resources were not distinct from development (Grove, 1995). Much of what was traditional practice was overturned or ossified following the imposition of colonial rule. From the devastating epidemics of first contact, through dynamically contested social change brought on by altered land use, constrained access rights and exclusion from decision making processes, Pacific Islanders and their environments have experienced radical change. Both were forcefully incorporated as 'instruments' for economic ends, and islanders as a group were never accorded an equal share of either profits or sovereignty (Hempenstall and Rutherford, 1984).

PIC communities experienced ongoing social instability and environmental vulnerability for the duration of colonial rule as control of their resources was altered and fragmented. For the Pacific countries, decolonisation is incomplete, and those islands that have nominal sovereignty remain dependent on earlier colonial powers to varying degrees.

3.2 Independence: a time of development or neo-colonialism?

3.2.1 Development strategies.

Independence was not sought or achieved by all Pacific Islanders, and where it was it took several forms (Figure 5). France and the US have steadfastly refused to grant independence to those islands which are considered to be of particular strategic importance, such as New Caledonia and French Polynesia for France, and Guam for the US.

Colonial Power	Incorporated Into colonial Power	Still dependent	Self-governing in free association	Independent
United Kingdom And France				Vanuatu (1980)
United Kingdom		Pitcairn		New Zealand (1907) Fiji (1970) Tonga (1970) Tuvalu (1978) Solomon Is. (1978) Kiribati (1979)
France		French Polynesia New Caledonia Wallis & Futuna		
New Zealand		Tokelau	Cook Is. (1965) Niue (1974)	Samoa (1962)
Australia		Norfolk Is.		Nauru (1968) PNG (1975)
United States	Hawaii (1959)	Am. Samoa Guam	Marshall Is (1986) FSM (1986)	
Northern Mariannas			Palau (1994)	
Chile	Easter Is.			

Fig. 5: Political Status of Pacific Island Groups (Chappell, 1999, 142).

An explicit concern for the development of island states began with the contraction of colonial empires following WW2 (Shand, 1980). Definitions of development vary. At its simplest it is economic 'betterment', indicated by increases in the per capita availability of goods and services (Arndt, 1975). At its widest it can be seen as '...an intentional, self-guided process...continuously improving well-being, whatever the concrete content given these goals by different societies in different periods of time' (Sachs, 1999, 29). Development in the Pacific has followed initiatives implemented elsewhere that seek to stimulate economic activity. Debate revolves around the control and allocation of resources, and the role of the state in this relatively new issue for the Pacific Islands (Burt and Clarke, 1997).

Following independence, the avowed aim of development policies, voiced by both donor countries and Pacific Island governments, has been self-reliance and sustainability (Thistlewaite and Votaw, 1992; James 1993; Connell and Lea 1999). Strategies have been based around four approaches: extractive industries (primarily mining, fishing, and forestry), commercial agriculture, tourism, and industrialisation (Wartho and Overton, 1999).

Mining, one of the original motivations for European exploration in the Pacific, is an important sector for Melanesia and several individual Polynesian islands where large phosphate deposits existed. Colonial administration had enforced a regime of ownership based on the mineral laws of the 'home' country. In the case of PNG the template was the Queensland mining ordinance (Banks and McShane, 1999). Traditional landowners were alienated and, where and when they resorted to protest, oppressed. Foreign ownership still dominates the mining industry in the Pacific. Controversy has accompanied some modern projects, often explosively, revolving around land rights, environmental degradation, and questionable political influence (Banks and McShane, 1999).

Fishing has become an important Pacific-wide industry, dominated by foreign vessels and companies and focused on deep-water migratory species of tuna and snapper (Tarte, 1998). PICs have struggled to maximise their returns from this resource, a situation repeated in the forestry industry where foreign companies again dominate. Non-sustainable logging rates and damaging practices are evident, as is high-level corruption (Kabutaulaka, 2000).

Although subsistence agriculture remains important across the region, large-scale commercial ventures are well established in the larger PICs. Limited land and isolation have prevented successful schemes in the smaller countries. Depressed global commodity prices, cyclones, pests and disease, poor marketing, transport and storage problems have hindered development (Chand, 1993; Clarke, 1994b). There is also the apparent reluctance on the part of small farmers to intensify their production, with many content to work towards a target sum and no more (Clarke *et al.*, 1999).

Perhaps the main constraint on modern development policies in the Pacific Islands has been the persistence of traditional tenure systems (Spate, 1959; Clarke *et al.*, 1999). This has made banks reluctant or unable to loan money to individuals who do not own clear title to land or other resources (Clarke *et al.*, 1999). Where projects have gone ahead without clear and legitimate consent of traditional landowners, problems have inevitably arisen over the benefits of development and the responsibilities and obligations of the various parties involved.

Tourism is increasingly important in the region and most PICs are developing tourism strategies. Isolation in this case can be a marketing advantage, along with the ascribed imagery of palm-fringed atolls and happy islanders held by Westerners. However, as an industry it possesses its own problems. Tourist numbers are subject to volatility beyond the control of PICs, returns are limited by other constraints (again the lack of domestic capital investment features), and increased pressures on culture and environment can be considerable (Wartho and Overton, 1999).

Diverse manufacturing sectors are evident in Fiji, Tonga, Samoa and New Caledonia. However, secondary industrialisation is generally not well developed, with isolation, lack of the necessary resources and energy, and a lack of capital investment limiting expansion in those countries where it exists and hindering industrial development in other PICs (Wartho and Overton, 1999).

Despite the nationalist rhetoric and continued attempts at economic 'betterment', Gross Domestic Product (GDP) statistics show that per capita wealth is generally *inversely* related to the degree of political independence (Bertram, 1999; see Table 2).

Table 2: Per capita GDP by Political status (US$). (Source: Betram, 1999, 338; on political status see Figure 5).

	All	Excluding PNG	Excl PNG & Hawaii
Sovereign territories (excl. NZ)	1,229	1,510	1,510
In Free association	2,187	2,187	2,187
Dependent	22,615	22,615	14,423
Region Average	6,351	11,979	5,046

Almost all development strategies have required assistance of donors of various forms to varying degrees (Wartho and Overton, 1999). Most recently this has taken the form of neo-liberal 'Structural Adjustment Programmes' (SAPs), promoted by the International Monetary Fund (IMF) and World Bank in indebted countries (Brohman, 1996; Preston, 1996). Privatisation is seen by the IMF, the World Bank, Asian Development Bank (ADB), and successive Australian and New Zealand governments as an effective means of creating a more efficient economy and encouraging effective development. The paring back of State control is an explicit goal and the distribution of economic, social, political, and intellectual resources is assumed to be most efficiently conducted by market mechanisms. It is further assumed that the role of the State is to provide the framework for individuals to pursue their private goals (Brohman, 1996).

The background of communal property rights means such policies are problematic and have been implicated in decisions to sell, or develop resources in efforts to pay for previously free or cheap health, education and other public services. For example, in 1992 a village in Vunivia, in Northern Vanua Levu, Fiji, cut down its coastal forest – a rare and ecologically important resource – to pay for a housing development (Weaver, 1003). Little research has been undertaken into these impacts although implementation of these policies is currently occurring in a number of PICs. (Chand, 1993; Warner, 1999; Kabutaulaka, 1999).

PICs are the recipients of the highest allocation of aid per capita in the world, and as Table 3 shows, for some PICs aid is a considerable component of national budgets.

Table 3: Aid to selected PICs and as a percentage of GNP (1994).
(Source: Hughes/ADB, 1998, 9).

	Aid (all sources) 1994 (US$ million)	% of GNP
Cook Islands	14.3	17.9
Fiji	40.4	2.3
Kiribati	15.4	25.7
Marshall Islands	49.3	54.8
Fed. States of Micronesia	104.2	52.1
Nauru	2.4	-
PNG	325.7	6.7
Samoa	48.7	30.0
Solomon Islands	47.0	16.2
Tonga	35.2	22.0
Tuvalu	7.4	-
Vanuatu	41.8	22.0

Many Pacific Islanders, particularly young men, travel abroad to work, often to developed countries around the Pacific. They send home part of their salaries, just as migrant workers did in the colonial era, although the sums now are much larger. This phenomenon is now well-entrenched across the Pacific. For some PICs such remittances make up a significant although poorly understood portion of the national economy (Bertram and Watters, 1985).

Although images of idyllic island life continue to be articulated, PIC economies and peoples are regularly deemed 'exposed', to economic volatility, unfavourable migration patterns, aid dependency, ill health, continued isolation, and environmental hazards and disasters (Bertram and Watters, 1985; Poirine, 1998; Briguglio, 1995; UNEP, 1999; Commonwealth Secretariat, 2000).

3.2.2 Health

The most graphic illustration of the region's problems is the often appalling statistics of ill-health released by various agencies and PIC governments. While mortality figures have shown improvements, especially infant survival rates, major concerns remain. Sir Peter Mekere, Prime Minister of PNG, in a speech opening the Fourth Pacific Island Health Minister's Conference spoke of Pacific Islanders' vulnerability to many diseases, including 'society-induced illnesses' for which he blamed the cash economy (Mekere, 2001). However, great variation across PICs is apparent in these diseases. The incidence of diabetes ranges from 0.8% for rural PNG to over 30% for Nauruans (Zimmet *et al.*, 1990 and Taylor and Thoma, 1985, in Pollock and Finau, 1999, 285). Hypertension levels range from zero in Pukapuka up to 35% in American Samoa (Pollock and Finau, 1999, 285).

Environmental change has been implicated in new health problems. (McMichael, *et al.*, 1996). An outbreak of Ross River fever affected the majority of Rarotongans in 1980, representing the easternmost extension of a virus thought to be limited to Australia, New Guinea and the Solomon Islands (Cliff *et al.*, 2000). Dengue fever has accompanied the spread of its carrier, the mosquito *Aedes aegypti,* which flourishes during the rainy season and has been more prevalent in recent years (WPRO, 2000).

The effective management of health services in the developing world is critical. Three outbreaks of 'yaws' in the Solomon Islands occurred in the 1980s after it was thought to have been successfully eradicated by the World Health (WHO) in the 1950s. A subsequent WHO programme was found to be inappropriate, and integration with the existing primary health system was deemed necessary (Fegan *et al.*, 1990, in Cliff *et al.*, 2000, 417). Campaigns to reduce the habitat of *Aedes aegypti* - commonly found in urban and peri-urban areas where it can breed in very small pools of water such as found in discarded tyres and tin cans - have struggled to overcome public apathy and ignorance.

PIC health services are bracing themselves for the impact of human immunodeficiency virus (HIV), the arrival of which has further exposed under-resourced services. The reticence of sufferers and their communities to openly confront the dynamics around HIV and the subsequent development of the fatal Acquired Immunodeficiency Syndrome (AIDS) has hindered simple recording of the effects, regardless of the availability of treatment. If this epidemic follows patterns observed in other traditional developing societies, an exponential growth in the number of cases can be expected (Cliff *et al.*, 1999). Tragically, this and other diseases of modernity will see many Pacific Islanders lead shorter lives, experience considerable discomfort, and – for their communities and national economies – a corresponding loss of productivity. The resources to effectively remedy these effects is arguably not beyond the ability of many communities and Pacific nations, but comprehensive improvement to the health of Pacific Islanders appears difficult.

3.3 Contemporary management of PIC environments.

3.3.1 Governance and legitimacy.

Local involvement in environmental management has been described as ranging along a continuum from non-participation to citizen control (Arnstein, 1969). In the Pacific, as elsewhere in the developing world, the debate on environmental management has been widened by the inclusion of 'indigenous knowledge' as an alternative perspective to (dominant) Western science (Berkes and Folke, 1998). Contemporary anthropological research has transformed the stereotype of 'primitives' in need of modernisation to greater respect for local, traditional-styled, management as being environmentally sustainable (Dwyer, 1994; Morrell, 1989). Yet as noted in Chapter Two, this knowledge is increasingly fragmented, and accurate indigenous knowledge may be as difficult to assemble as the 'rational' quantified data of Western science.

Traditional institutions have struggled to cope with contemporary problems, and the legitimacy of contemporary jurisdictions in the management of PIC environments is of

growing concern. Absentee chiefs, many of whom have migrated to urban areas, have contributed to the erosion of traditional authority. In Ucunivanua, Fiji, this has resulted in the 'remote controlling' of leadership, and the exerting of demands by those who remain to the detriment of co-ordinated management of fishing activities (Vunisa, 1994, 205).

Absentee landowners, many now living in Pacific Rim countries, complicate traditional practice and development attempts. Concerns that Cook Islanders resident in Australia and New Zealand have veto rights over development decisions as well as a share in profits of those that proceed in their home countries has led to calls for amendments to the Land Facilitation Act (Brown, 2000). For Rotuma, (a culturally-distinct island to the north of Fiji, to which it is constitutionally bound), the problem has been 'absentee' expertise, that is Rotumans who are educated and experienced in modern management culture residing in Viti Levu, Fiji. These professionals question and 'upstage' the authority of Rotuma-based traditional chiefs. These chiefs face the dilemma of being expected to formulate policy for development, assume fiscal responsibility and administer various programmes without the proper education or training, leading to a certain resentment by their people (Howard, 1996).

There are examples of successful community involvement in resource management in the Pacific. In the Cook Islands, an individual transferable quota system was introduced on the island of Aitutaki (population around 2,000) in 1989 which saw every household allocated an amount of Trochus (*Trochus niloticus*, a marine gastropod valued as a source of mother-of-pearl). The intent was to alleviate pressures on this resource that were caused by excessive harvesting in a limited season. The successful introduction of this system involved close co-operation between the Cook Islands government and the Aitutaki Island Council (Adams, 1998).

Another success story concerns the creation of a marine reserve in the Lomaiviti Province of Fiji in 1990. Such reserves have been difficult to establish in the Pacific due to the prevalence of at least vestiges of traditional tenure rights (Adams, 1998). Despite (or perhaps because) the Makogai marine protected area in Lomaiviti is not actually

legislated, and the process not involving the conservation service but the Fisheries Division, it has been considered the most successful scheme in Fiji (Adams, 1998). Fishing has not been banned, and although encroachments have occurred, mainly by outsiders, Makogai is an example of a co-management arrangement in which government officials have worked through traditional institutions and achieved community support (Adams, 1998).

Success of the sort noted in the two examples above relies on effective communication and the acceptance of and respect for local authority by both national bodies and involved communities. These two features cannot be guaranteed and may be increasingly difficult to achieve as Pacific Islanders continue to migrate. Advances in technology have provided some hope of providing new means of contact and communication for the increasing Pacific diaspora. The Rotuman community now transcends its island boundary and is increasingly diffuse, yet recent attempts to utilise the World Wide Web has seen an ambitious project of constructing an archive to facilitate Rotuman community knowledge and identity (Howard, 1999).

These technological achievements and their changes to our ability to interact across space have not, however, removed the realities of specifically located problems in the Pacific. Discrimination on the grounds of ethnicity or gender occurs across all societies in the region. The May 2000 coup in Fiji showed that racial discord remains a feature within that country, with Indo-Fijian communities subject to violence and threats that has encouraged those who can to emigrate, often following family members who left following the coups of 1987 (Lal, 2000). Women across the Pacific have been alienated from many modern projects – as owners, users and custodians – even in matrilineal systems as traditionally practised in parts of the Solomon Islands (Kabutaulaka, 2000). SAPs have impacted differently on men and women, in general undermining the subsistence activities of women (Cockerton, 1999). A major concern is the incidence of domestic violence in the Pacific, reported as affecting 60% of women in PNG and 30% in Samoa (Waram, 1995; Peteru, 1996). With such immediate concerns, environmental

management, for all its acknowledged importance, has often not been accorded the priority many Western commentators believe it is due.

The administration and enforcement of environmental legislation suffers from systemic problems founded in colonial legal frameworks, and the lack of trained people and resources (Carew-Reid, 1990; Brunton and Barlow, 1997). In 1993, Vanuatu had just three officers monitoring the timber industry. Visits to isolated island sites were irregular and dependent on company cooperation for transport (Garret, 1993). In the Solomon Islands, the Forest Resources and Timber Utilisation Act was framed by the colonial administration and did not permit logging of traditional-tenured land. When this was eventually permitted, ascertaining ownership rights was side-stepped by a process biased against traditional owners, leading to ongoing disputes and disappointments (Sheehan, 2000). The constraints due to traditionally-framed gender relations have implications for the monitoring and enforcement of various resource issues. Many Pacific Islanders would experience difficulties if female officials were required to enforce regulations (Adams, 1998).

Some commentators have argued that the overlying power structures may place constraints on avowedly eco-friendly or pro-indigenous policies (Memon and Perkins, 2000). As many PIC industrial and business ventures involve non-PIC players for capital, markets or knowledge, an international management context is explicit. This is, however, weighted heavily against Pacific Island communities. The resources that a large company like Australian-based Broken Hill Properties (BHP) can bring to bear on a country like PNG is evident from its influence on the decision-making process surrounding the Ok Tedi mine. This large project was exempted from the 1978 Environmental Protection Act following a company generated report that was considered more 'appropriate' (Townsend, 1988).

The rudimentary connections PICs had with an expanding global economy have become increasingly pervasive. The involvement of established multinational corporations, often with experience of similar environments in Asia, facilitated the rapid exploitation of

Melanesian hardwood forests (Barlow and Winduo, 1997). Similar concerns are held over the mismanagement of mining operations, overexploitation of marine resources, and the degradation of both urban and rural landscapes (Kabutaulaka, 2000; Filer, 1999; Johannes 1978). Conflict has erupted into violence, notably on Bougainville where a vicious war between aggrieved landowners and PNG government forces resulted in the deaths of between 3,000 and 5,000 people and has only recently reached settlement (Regan, 2000).

Sovereignty for those PICs that achieved or were granted it has not translated into the form of independence hoped for. Contemporary indigenous leaders can not necessarily 'engineer' fundamental social or economic changes in their societies. Their legitimacy is often contingent on their ability to provide desired services in health and education, and 'rural' development (Wesley-Smith, 1999). Corruption is regularly reported and occasionally proved. While some cases expose the problematic nature of bureaucratic control in small kin-based societies, large-scale fraud and misappropriation of public funds has occurred (Larmour, 1998). In 1997 the Vanuatu Ombudsman investigated French funds targeted for the relief of damage by Cyclone Betsy (1992). It was discovered that non-attributable deposits of $US1.1 million were held in bank accounts controlled by the Prime Minister. Another outcome of publicity surrounding corruption in the Pacific is to detract from charity efforts, as occurred after the Sefa tape scandal (when the PNG Prime Minister was secretly filmed handing over money to bribe the media) affected aid to assist with the severe drought affecting PNG at the time (Vulum, 1998).

The continued role of other States and large multilateral agencies has led to cries of neo-colonialism (Marsh, 1999). The current Australian policy of relocating refugees on Pacific Islands has been described by the Prime Minister of Vanuatu as the 'big brothers' of the Pacific imposing upon smaller nations (Natepai, 2001). Increasing focus is being placed on a framework in which the large corporations of this world are seen not solely as participants in the 'free' market but agents of market governance (Harris, 1998). While communities across the Pacific region are experiencing harsh global market realities (such as fluctuating commodity prices and devalued currencies), corporate interests seem to benefit from government legislation and financial spin-offs from vested interests. The

historical experience of an imperial centre controlling peripheral colonies by government officials and aristocratic rulers has been replaced by closed boardroom meetings and commercial relationships in which the wishes of the many are subordinate to the profits of the few. While colonisation and the influence of missionaries initially led to a decline in warfare, violent intergroup conflict has been on the rise in recent years, particularly in Melanesia, and the rhetoric of development seems more exposed than ever before for not delivering social progress to the majority of Pacific Islanders.

3.3.2 Transboundary issues: Implications and responses.

PIC policy makers have only recently acknowledged the environmental impacts of development. High population growth rates and the displacement of traditional practises by introduced management practices have placed unprecedented stress on land and marine resources and the communities dependent on them (UNEP, 1999). Limited availability of arable land has seen subsistence gardening extended to increasingly marginal areas. Increasing urbanisation, dredging, nutrient run-off and landfill threatens reefs and lagoons. Some coastal resources are physically destroyed during developments such as the expansion of port facilities to accommodate extra capacity from regional and global trade requirements (Thaman, 1993; UNEP, 1999).

Contemporary research and increasing empirical evidence that global processes now play a major role have radically changed the debate on local and national environmental management in the Pacific. The recognition of human pressures on the global environment was forcefully articulated on the world stage in 1972 at the World Conference on the Environment and Development (WCED), generally referred to as the Stockholm Conference. Earlier concerns existed, for example threats to the life-sustaining qualities of the atmosphere were noted in the 17th century and actively researched in Europe in the 19th century (Tolba *et al.*, 1992). However, by raising the spectre of acid rain, Baltic Sea pollution and pesticide levels in fish and birds, the Stockholm Conference formally introduced the 'accidental internationalisation' of environmental problems, and opened the way for the environmental movement to become global (Sachs, 1999, 57).

The susceptibility of PICs to environmental change is now well established. (Overton and Scheyvens, 1999; UNEP, 1999; Nurse and Sem, 2001). Major concerns are now expressed regarding global environmental processes, particularly climate change and its affects on the frequency and intensity of tropical storms, greater variability in rainfall, and the prospects for accelerated sea-level rise (Nurse and Sem, 2001). Problems of this magnitude and extent will require very different responses from nation-states than have previously been considered necessary.

The Stockholm Conference established linkages between the environment and development, broached the contrasts and conflicts between the developed and developing worlds, and introduced the important role that non-governmental organisations (NGOs) have to play (Gupta and Asher, 1998). For the purposes of environmental management, sovereign delimitations of space impede the resolution of global environmental concerns such as climate change, loss of biodiversity or accelerated sea level rise. What is apparent for the purposes of management is that global or regional environmental systems can be neither 'annexed' nor left without regulation (Hardin 1968; Imber 1996). The need for jurisdiction has been increasingly asserted across an increasing range of scales from the household to the planet, and further into the future (Lovelock 1979; Elliot, 1998).

The implications for this in the Pacific region are several. Transboundary environmental problems require cross-sectoral co-operation between nations; the networks for this may not exist, or may not be well developed. Likewise, the capacity for effective regional-scale environmental management may be lacking. Also, PIC governments are no different from many other governments in that they have dilemmas of conflicting short, medium and long-term goals, played out in a political arena imbued with traditional values and hierarchies where formal democratic practice is relatively new. As a result, PIC governments struggle with the obligations and responsibilities of framing environmental policy and implementing effective management.

3.4 Measuring development and the Environment.

The concerns noted above and the continued environmental degradation experienced by PICs have challenged the assumption that Euro-American models are the best means to develop resources (Howard *et al.*, 1983). Some commentators have argued that the Pacific region is subject to a 'conveyor belt' mentality whereby the latest Western concerns are automatically transferred to PICs with minimal penalties for failure (Hau-ofa, 1998). Originally explicitly economic in scope, the focus of development has been questioned by many Pacific leaders and commentators. Tabia (1987), speaking as President of Kiribati, has sought a 'viable and dignified' way of life for his country. James (1993) has argued that Pacific Islanders enthusiastically pursue their own development goals within the social and cultural realms via an informal sector, seeking to satisfy various non-material needs while protecting social organisations and kinship systems.

The evaluation of successful development policies beyond the simplistic recording of economic indicators is problematic. The ubiquitous use of Gross National Product (GNP), its components, and their growth was inspired by the national accounting methods of Western economists in the post-WWII period. With the rise of development efforts in this same period, often involving Western-trained economists, there was a progressive transfer of these measures to the developing countries after the 1950s (Hicks and Streeten, 1979).

The limitations of these conventional development indices to describe the reality of individual and community experiences were expressed early on (Hicks and Streeten, 1979). In response the UN Research Institute for Social Development (UNRISD) sought to develop composite social indicators during the 1960s (Drewnowski and Wolf, 1966). The 1970s and 80s saw a number of social indicators promoted, principally related to health, education and nutrition, as the literature on development began to promote a wider range of concerns (Becker and Jahn, 1999). Efforts to include both growth and quality of life indicators resulted in the Human Development Index (HDI). Developed by the UN Development Programme (UNDP), this method reduced the 'quality' of human life to

three 'essential' aspects: longevity, knowledge, and the resources considered necessary for an acceptable standard of living (UNDP, 1994, 8). Quantified as measures of life expectancy, literacy (specifically adult literacy and the mean number of years at school), and per capita income, the HDI has provided a little more insight for intercountry comparisons than GNP per capita (McGillivray, 1991).

Critics have called for the utilisation of radically different indicators than either the HDI or GNP, requiring new data and not new ways of expressing existing indicators (McGillivray, 1991). Some argued for observable and measurable indicators, others for a more flexible approach such as institutional processes as judged qualitatively to precise criteria by experts (Adelman and Morris, 1971). Human development is 'inherently multi-dimensional' and to fully assess all its components requires a variety of data on social, economic, political and cultural elements (UNDP, 1994, 8). However, criticisms of development statistics do not negate their value in analysing development, particularly its spatial unevenness, and so despite these problems, aggregated indices remain popular for summarising world development trends over time and space (Seers, 1972; Potter *et al.*, 1999).

Threats from environmental degradation have increased the number of criteria by which development policies for PICs are measured. The Secretary General of the Pacific Islands Forum Secretariat, Noel Levi, expressed regional concern in an address which called for the promotion of industries in the Pacific "*...to be carried out in a manner that is sustainable, especially in light of the vulnerability of our physical environment.*" He went on to say that Forum members had suffered "*irreparable damage to their environment, ... attributed to the pursuit of export-intensive growth.*" (Levi, 2001).

Calls for 'sustainable' development now come from many stakeholders, particularly the policy platforms of various 'Green' parties and environmental groups, and it is a formal policy requirement expressed in major international fora. Its origins can be traced to the Brundtland Report in 1987 that argued for a world-wide commitment to meeting "...the

present needs without compromising the ability of future generations to meet their needs." (World Commission on Environment and Development, 1987, 43).

Sustainability has been categorised as a 'system property', akin to the resilience concept, and defined as 'the ability of a natural, human or mixed system' to withstand or adapt to change perceived as threatening (Dovers, 1997, 304). Sustainable development is the implementation of policy that enhances this property (Dovers, 1997). Therefore the assessment and monitoring of environmental characteristics is an important element in improving policy responses (Memon and Horton, 1995). Despite the ubiquitous presence of sustainable development discourse in contemporary debate, for the purposes of management responses, PICs possess relatively little accurate long-term data on their environments.

Social development in the Pacific has been plagued with data problems revolving around the issues of reliability and cultural attitudes to the importance of these data (Bakker, 1986). Similar constraints exist with environmental data, and the development of scientific and policy capacity in the Pacific region response to environmental change, particularly that concerned with climate, is growing from a very small or non-existent base (UNEP, 1999). For the purposes of mitigating the contemporary environmental problems faced by PICs there is a fundamental lack of knowledge on the integrity of their domestic and regional environments (UNEP, 1999).

Environmental management practice for PICs remains cognisant of the traditions that have evolved within the unique contexts of widely scattered islands of great variety, both in size and features. Cultural values are more strongly held in PIC communities than their island counterparts in the Caribbean and Indian Oceans, indicating that a 'one size fits all' policy for SIDS is not possible (Commonwealth Secretariat, 2000). The range of environmental concerns facing Pacific Island communities requires accurate and meaningful assessment. How this is to be achieved is both a complex and pressing problem.

3.5 Conclusions

Pre-contact Pacific Island communities generally used their resources sustainably through the maintenance of communal control, and by inter-communal networks of trade and exchange. The detailed knowledge of Pacific ecosystems, within which islanders considered themselves integral components, meant that the precise allocation and harvesting of resources was possible. Access to resources was based on traditional rights that were not fixed, and changes could occur as a result of negotiation, conflict, conquest and migration.

The establishment of foreign control predicated on the exploitation of both human and physical resources altered these relationships. Founded on conceptions of racial superiority and strategic self-interest, early policies were based on Western experience and sought to effect a transition to a 'modern' society considered separate and superior to 'traditional' societies. Interactions between Pacific Islanders and their environments were drastically altered, as were social relations and life styles due to the encroachment of a cash economy, the intrusion of new beliefs (although these were often tempered by tradition) and Western material goods.

Colonial powers were reluctant to relinquish control and continued to influence governance even after independence. Having sought powerful individual leaders who recognised the benefits that could accrue through interaction with the new political and commercial forces, these indigenous elites, often from outside of traditional hierarchies, facilitated the implementation of colonial policies. Following Independence, many assumed control or positions of influence where they then facilitated the implementation of development policies and oversaw the increasing globalisation of the region.

This has led to a situation where many environmental practices in the Pacific region are based simultaneously on the legacy of colonial rule focused on extractive industries, and indigenous 'traditional' values that are enforced via outmoded institutions. Ironically, the latest attempts at securing an economic base through tourism rest on the earliest interpretations of Pacific Islands as idealised tropical paradises for rest and recreation.

Subsequently, communities and individuals have found themselves subject to conflicting pressures from a variety of sources, from the spiritual and communal, to national governments or foreign corporations.

Independence has not meant isolation for PICs, but rather the reverse with a large increase in the number of states and organisations providing development support. Questions remain over the legitimacy of jurisdiction, the allocation of resources, and paths for future development. Economic and social indices indices reveal the anomalous position Pacific nations find themselves in, whereby they are receiving relatively large aid payments yet remain unable to secure satisfactory results for many citizens or aid donors. While contemporary transboundary issues may be beyond the total control of small and isolated Pacific communities, valid and valuable responses can be made. The need for the accurate assessment and monitoring of PIC environments is therefore of greater relevance than ever to inform national, regional and global environmental policy.

The implications for mismanagement of the Pacific Island environments in this context are serious. Efforts by policy makers to utilise scientific findings must first overcome the complexity and uncertainty that this information entails. The requirement for simple expressions to deal with environmental assessments and monitoring efforts must be viewed in this light.

Chapter Four: Supranational Policy in the Pacific.

The previous chapter showed that contemporary environmental problems involve and encourage a wide network of linkages beyond the shores of PICs. This chapter will outline the formal organisations through which agreements reached at the global level are ultimately translated into policy directives at the regional and national levels. First an examination will be undertaken of those global organisations that have a major role to play in contemporary environmental management issues. The role of global science and capacity to advance effective policies will also be outlined. The Pacific regional context will then be described, culminating in an outline of PIC action to investigate their environmental vulnerability. This will introduce the work of the South Pacific Geoscience Commission and its role in assessing and communicating Pacific environmental vulnerability.

4.1 Environmental Organisations.

While there were organisations in ancient civilisations, it is a hallmark of modern society that a very large number of organisations are responsible for a diverse range of social functions (Scott, 1998). In the immediate aftermath of WW2, the United Nations was established as a 'centre for harmonizing the actions of nations' (Thacher, 1992, 183). This was considered a prerequisite for the solving of various international problems and creating the necessary social, cultural and humanitarian conditions for maintaining peace (Thacher, 1992). Subsequently a number of intergovernmental organisations (IGOs) were established, among them the Food and Agricultural Organisation (1945), the UN Education, Scientific and Cultural Organisation (1946), the World Health Organisation (1946), and the UN Development Programme (1966). These and other UN-inspired organisations are elements of 'a grand ameliorative endeavour' that seeks to bring about an improvement in the conditions of under-privileged people (Galtung, 1986, 60).

There are aspects of this global organisation phenomenon that are not solely or specifically concerned with the conditions of humans, for instance the World Conservation Union was

founded in 1948, and the World Wildlife Fund, 1961. The momentum of these expressions of environmental awareness was continued by the 1960s 'counter-culture' movement, growing empirical evidence of environmental damage, and as the modern Euro-American environmental movement led a growing demand for international environmental management (O'Riordan, 1995). The Stockholm Conference raised international environmental awareness, and lead to the UN General Assembly establishing the UN Environmental Programme (UNEP). Headed by a respected scientist (Mostafa Tolba) and based in a developing country, Kenya, UNEP's role was to monitor and report changes in the environment, analysing the causes of change, and to engage with nation-states to develop appropriate responses (Tolba *et al.*, 1992).

The UNEP supported negotiations for 40% of the 140 environmental treaties signed up until 1988 with its Regional Seas Programme alone resulting in 23 treaties between 1975 and 1983 (Haas, 1990, 348). Over this time several changes were evident: the focus shifted from less problematic marine pollution to land-based sources, efforts became more comprehensive, and knowledge of ecosystems increasingly informed these initiatives. These changes involved international decision makers accepting a broader, inter-dependent 'symbiotic and holistic conception' of the environment for the purposes of environmental policy making (Haas, 1990, 349). Since 1974 UNEP has produced an annual 'State of the Environment' study, each focusing on a limited number of issues. More comprehensive reports were released in 1982, 1987, and 1992. While paying heed to the successes, these reports document the increasing evidence of environmental change, and the uneven response of governments (Tolba *et al.*, 1992).

These advances indicate that a broad 'epistemic consensus' has been achieved by environmental research and policy agencies (Haas, 1990). While scientists may disagree over precise cause and effect relationships, consensus has been achieved in a number of highly complex fields, notably the control of emissions into the atmosphere. However, a comprehensive agreement between wealthy developed countries and the developing world has proven elusive. The need for this is continually stressed in policy statements, yet major differences still exist in perceived obligations and responsibilities of developed and

developing blocs. Political expediencies continually dilute and compromise efforts to implement and enforce effective environmental policies.

UN General Assembly Resolution No. 44/228, adopted in 1989, set the guidelines for the important 1992 UN Commission on Environment and Development (UNCED) meeting, usually known as the Earth or Rio Summit. The principal concern was '...maintaining the quality of the Earth's environment and especially in achieving environmentally sound and sustainable development in *all* countries' (Pramanik, 1993, 12, emphasis added). Like Stockholm before it, the Rio Conference led to a number of agreements, notably the UN Framework Convention on Climate Change (UNFCCC), the Convention on Biodiversity, and the Declaration on Forest Principles. There was, however, a notable lack of compliance timetables and targets (Pramanik, 1993).

Further articulation of the Rio platform was achieved via Agenda 21. This provided the framework for comprehensive programmes that would enable regions and states to reduce environmental damage and seek sustainable development, in other words to 'reshape' societal behaviour (Pramanik, 1993, 13). Although adopted by consensus, developing countries conceded their demands for specific aid commitments from the industrialised nations (Pramanik, 1993).

Debate over administering the environment is no longer the preserve of States and their co-operative bodies. Along with IGOs, a diverse number non-governmental organisations (NGOs), existing outside the mandate of governments, have evolved to become an integral part of a 'global civil society' (Walzer, 1995). At the Rio Conference, over 1,400 NGOs were officially accredited, advocating in the area of the environment or development or both (La Rivière *et al.*, 1996, 165). These organisations attempt to 'pressure, cajole, or otherwise influence' the actions of governments and their policies (Conca, 1996, 104).

Large multilateral financial organisations have also exercised influence over states, although with considerably more financial resources and a very different starting point to NGOs, namely economic growth. They have made attempts to incorporate the concerns of

environmentalists. The then senior vice president of the World Bank, David Hopper, said in 1988 that the Bank "...will be addressing the full range of environmental needs of its partner nations, needs that will run from the technical to the institutional, from the micro-details of project design to the macro-requirements of formulating, implementing and enforcing environmental policies." (cited in Sachs, 1999, 65). The Asian Development Bank (ADB), a major contributor of funding in the Pacific, has also acknowledged the importance of sustainable development in the region, given the scarcity of land and the 'fragility' of the environment (Chung, 1992, in Thistlewaite and Votaw, 1992, vii).

Despite these stated intentions, several large failures connected to World Bank lending practises were exposed by a number of loosely allied environmental NGOs, including a colonisation settlement project in the Brazilian Amazon, and the Sardar Sarovar dam in north-central India (Conca, 1996). Such problematic involvement has led to charges that the environmental commitments of such financial organisations are 'façidiste', that is they may have 'great elegance' but are producing 'an illusion that the spirit and style of the façade pervades the structure from within' (Piddington, 1992, 218). Criticism of the development rationale of these large organisations continues (Conca, 1996).

While predictions of the demise of the nation-state continue, and the input from non-state organisations increases, states remain crucial to the management of global environmental issues by directly negotiating the international legal framework and deciding both directly and indirectly what issues to promote or ignore domestically. Sachs (1999) argues that in many respects, environmentalism provides the justification for state jurisdiction over the lives of its citizens. Whatever the source and motivation, there has been a proliferation of regulations prescribing the human actions in the use of the domestic natural environment. As has been described in Chapter Two, contemporary regulations that are concerned with the environment to varying degrees utilise science in their development.

4.1.1 Science and multilateral environmental agreements.

The use of science in international environmental conventions, while universally supported, remains subject to political will and administrative procedures. In certain areas such as genetic

engineering and environmental toxicology, science is not just responding to but actually setting the political agenda (Timmerman and Munn, 1996). The source of advice, how it is to inform the regulatory process, and for what spatial scale, are all important factors in how science shapes policy. Three options are generally available. Individual countries can solicit data from their own scientists, the multilateral organisation concerned can employ its own scientists for the role, or an outside scientific body can provide advice (Birnie, 1992).

As was outlined in Chapter Two, modern science operates within a socio-political context, is international in extent, and subject to market mechanisms. These factors have advantaged the growth and legitimacy of science in certain societies, generally those described as 'developed' (Gaillard *et al.*, 1997). Indeed, science and technology are key characteristics of what is meant by 'developed'. One outcome of this is that developing countries regularly find themselves 'beholden' to the scientific activity of the developed world for information, and this puts them at a disadvantage in the negotiating process (Timmerman and Munn, 1996, 114).

The input of science can be problematic as shown by attempts to regulate marine pollution. As nearly every convention in this area defines marine pollution as *observable* harm, which is largely measured by changes in various species numbers, and this environment is constantly fluctuating, pollution effects are not necessarily readily distinguished from natural change (Stairs and Taylor, 1992). The science surrounding atmospheric pollution by Ozone Depleting Substances (ODS) reached relatively quick agreement in the form of the Montreal Protocol (implemented in 1987), and various strategies aimed at reducing those pollutants have been put in place (Elliott, 1998). However, the issue of whether observable changes to the atmosphere are caused by anthropogenic factors or natural causes has resulted in a moribund process of self-interested political manoeuvring framed by securing economic interests (Paterson, 1996).

A key change to the way that organisations dealt with scientific uncertainty is evident in Principle 15 of the 1992 Rio Declaration: *Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation* (UNCED, 1993, Principle 15).

Known as the Precautionary Principle, it has had a profound affect on the framing of environmental policy, and has more clearly delineated the line between economic and political interests on the one hand, and social and environmental issues on the other.

The majority of the agenda at Rio was based on science, although ultimately the outcomes of these debates had to be expressed in political and economic terms (Timmerman and Munn, 1996). In many areas of scientific research, the relationships between economic, political and scientific activity are becoming blurred. Dovers (1995) argues that when debate of this kind is most controversial, this generally indicates that systemic reform, as opposed to marginal challenges, is at stake in policy decisions. Concerns over the integration of environmental science into the processes of development were highlighted by an Organisation for Economic Co-operation and Development (OECD) report into the application of assessment procedures which noted the lack of sufficient political awareness of the need for environmental assessment, insufficient public participation, inadequate legislation, the lack of scientific data and information, and insufficient capacity (Carew-Reid, 1989).

4.1.2 Capacity and funding.

The lack of 'capacity' for meaningful environmental policy implementation in developing nations, and the need to finance the necessary research that would inform such policy, have proved ongoing problems. Capacity in this context is defined by Agenda 21 as a country's 'human, scientific, technological, organisational, institutional and resource capabilities' (UNCED, 1993, quoted in Thomson, 1996, 1). SIDS, particularly the Pacific members, have been among the most severely constrained countries in this respect (UNEP, 1999; Commonwealth Secretariat, 2000).

Efforts to counter these concerns revolve around aid packages, and bilateral and multilateral funding programmes. The dominant approach has been framed as 'technical co-operation' modelled on 'expert-counterpart' relationships, whereby an expatriate expert performs a job alongside a local counterpart. This approach has generally failed for a number of reasons: it was expensive and the salary differentials caused resentment and tension; the level of training

was too abstract; it was donor-driven and undermined local involvement; and it was limited to formal state organisations, ignoring ordinary people, the private sector and NGOs (Thomson, 1996). While efforts to widen capacity-building initiatives are now underway, similar criticisms continue to be voiced in the developing world.

Linked to the lack of capacity is the issue of funding. The Global Environment Facility (GEF) - an outcome of the UNCED/Rio Conference – is designed to address funding issues. Established in 1991, the GEF was originally conceived as a three year pilot programme to pay for selected costs of reducing greenhouse gas emissions, protecting biodiversity, managing international waters issues and general energy conservation. Jointly managed by UNEP, UNDP and the World Bank, it is advised by a scientific and technical advisory committee (O'Riordan, 1995). The GEF is the main body that mediates transfers between developed and developing nations. Initial funding of US$1.6 billion was increased by US$2 billion in 1994, and US$2.75 billion in 1998 (Ministry of Foreign Affairs and Trade, 1999, 212). This makes the GEF the most significant funding development to emerge from the UNCED/Rio meeting (O'Riordan, 1995). However, there are concerns over its operations, primarily due to the World Bank being the main funding body. These relate to broader criticisms of the World Bank as condoning the mis-management of resources when it does not speak out, despite regularly placing conditions on its support for other aspects of its lending programme (O'Riordan, 1995).

Some observers have countered developing countries' claims of poverty for not undertaking necessary steps in disaster mitigation and environmental protection with arguments that poor countries cannot afford *not* to undertake such measures (Jones, 1992). This, however, ignores the very obvious position that the developing world finds itself preoccupied, intellectually and financially, with short-term survival.

4.2 The Pacific regional context: contemporary organisations.

The origins of regionalism in the Pacific were evolutionary rather than revolutionary (Herr, 1994). It was both a product of prior colonial control, and a means by which PICs could engage the world and each other following independence. Pacific Island governments, like colonial administrations before them, hoped to achieve economies of scale where possible. Whereas the colonial powers could achieve this within their own bureaucracies, PICs have had to meld different cultures and governance frameworks at the regional scale.

Regional co-operation has been consistently dominated by a limited number of themes, principally a pre-occupation with economic development and the dependence on external support. Accusations of Pacific regionalism having undue 'introspection' and a limited scope have been made (Herr, 1994, 283). The articulation of a unique 'Pacific Way' of conducting regional and national affairs – based on consensus decision-making – regularly features in contemporary political debates (Mara, 1997).

At the regional level, the main Pacific organisations are co-ordinated through the workings of the Council of Regional Organisations of the Pacific (CROP). Comprising eight members, the oldest of these is the Secretariat of the Pacific Community (SPC). Established prior to decolonisation in 1947, the SPC was originally comprised of the six 'ruling' powers: Australia, France, New Zealand, the Netherlands, U.K. and U.S.. According to Moore (1982) its rules and functions were paternalistic, and while it intended to improve 'conditions' for island peoples, this was to be achieved within the status quo of colonial authority and politics were expressly banned from discussion (Moore, 1982). It now has five metropolitan members (The Netherlands has now withdrawn) and 22 island countries and territories, and is based in Noumea, New Caledonia.

Discontent from indigenous leaders with the SPC saw efforts to establish a parallel organisation. This led to the formation of the South Pacific Forum (SPF) in 1971 whose members were the 15 independent and self-governing countries in the Pacific. Administered

by the Forum Secretariat (FS), it has a pivotal role for PIC co-operation because it is the permanent chair of the South Pacific Organisations Co-ordinating Committee (SPOCC). Since the UNCED/Rio Conference, the SPF has delivered an annual Forum Communiqué outlining its commitments to UNCED and consequent policies and sustainable development initiatives (Miles *et al.*, 1996).

The regional harvesting of migratory fish species, dominated by foreign companies extracting tuna, was of increasing concern and led to the establishment of the Forum Fisheries Agency (FFA) by the independent states of the Forum in 1979. Broadly aiming to assist its members in obtaining maximum sustained returns from their fisheries, in practice the FFA is concerned with managing and developing tuna resources, primarily through negotiation of agreements among members and with developed world partners (UNEP, 1999).

Research and tertiary education was promoted through the establishment of the University of the South Pacific (USP) in 1968. Suva was the first campus, and two others have been established in Apia (Samoa) and Port Villa (Vanuatu). Each of the 12 member countries now have some physical representation of its various schools and extension services. The number of students enrolled in 2000 totalled 9118, compared with 8773 in 1999. Of these, 4914 studied either full-time or part-time at one of the University's main campuses; the remaining 4204 chose to study by distance education (USP, 2001).

The tourism sector comes under the aegis of the South Pacific Tourism Organisation (SPTO). The SPTO began as an initiative from an informal grouping of national tourism organisations that formed themselves into the Tourism Council of the South Pacific in the early 1980s. The actions of this Council revolved around a series of assisted programmes, supported by the European Union (South Pacific Tourism Organisation, 2001). A permanent secretariat was opened in Suva when the Council became a recognised regional IGO. A 1998 review saw the organisation renamed the South Pacific Tourism Organisation (SPTO). SPTO's objective is to foster regional co-operation in the development and promotion of tourism to and within the island nations of the South Pacific. It is funded by government members, industry membership fees, commercial activity and by donor support programmes. Lately the SPTO has become

more market oriented as it increases its activity on behalf of the private sector in the region (South Pacific Tourism Organisation, 2001).

Specific issues of development are the concern of the Pacific Island Development Programme (PIDP), which is the research division of the Pacific Islands Conference (PIC) based in Honolulu, Hawaii. Founded in 1980, this organisation is seen by some as being closely identified with the interests of the US, as most funding came from the US State Department and other US agencies (Neemia, 1986).

The South Pacific Geoscience Commission (SOPAC) began in 1972 as the Committee for Co-ordination of Joint Prospecting for Mineral Resources in South Pacific Offshore Areas, a UN project under the control of ESCAP. Its principle role has been to advise members on offshore prospecting, nearshore activities, resource surveys, and the effects of modifications to coast, water and sanitation. SOPAC co-ordinates with SPC on health-related matters, and with SPREP on pollution issues (UNEP, 1999).

These organisations are involved with environmental issues to varying degrees. However, most environmental concerns are addressed by the South Pacific Regional Environmental Programme (SPREP). SPREP evolved from a 1969 workshop focusing on nature conservation. As a result, the SPC in 1973 supported a programme for the conservation of nature that led to the establishment of the South Pacific Regional Environment Programme in 1982. The programme was co-ordinated by representatives of the South Pacific Bureau for Economic Cooperation (now the South Pacific Forum Secretariat, UNEP, the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), and South Pacific Commission. Comprising 27 members, including four developed countries with direct interests in the region (Australia, New Zealand, France and the US), SPREP's position has strengthened apace with the growing environmental awareness world-wide. In 1991, member governments began negotiating to establish SPREP as an independent regional organisation, and this was completed in 1995. The new status allowed SPREP to better organise and further assist PICs in international environmental negotiations, and improve financial resources for

appropriate environmental policy and the implementation of agreements. SPREP is based in Apia, Samoa.

There are a number of other players who influence environmental management in the Pacific region. From the 1980s, the number of foreign NGOs concerned with environmental issues in the Pacific increased; over 1,000 NGOs were active in the region in the early 1990s (Crocombe, 1992, 17). Social concerns have also been acknowledged by certain organisations with regional concerns, indeed many of these groups readily combine issues of social justice and environment. In the Pacific, smaller or less powerful groups struggle to function in an often hostile context (USP/ISP, 1986).

Regionalism in the Pacific has been predominantly funded by external sources, either governmental, multilateral or otherwise voluntary (Crocombe, 2001). It has been acknowledged that the benefits of regionalism and integration have disproportionately accrued to the economically stronger PICs (Siwatibau, 1997). This situation is continuing and unlikely to change in the foreseeable future.

4.3 Pacific environmental policies.

4.3.1 Development.

Modern Pacific regional programmes that were specifically concerned with the environment were established in the early 1970s. The UNEP 'regional seas' concept, launched in the mid 1970s in response to the need for international co-operation to protect the marine environment, was realised for the South East Pacific in 1981, and the South Pacific the following year (Tolba *et al.*, 1992). A symposium on the Conservation of Nature, Reefs and Lagoons, jointly sponsored by the SPC and the International Union for the Conservation of Nature (IUCN), was held in 1971 and led to the appointment of a Regional Ecological Advisor in 1974. In 1976, under the direction of the Forum and with the co-operation of UNEP, a South Pacific Conference on the Human Environment led to the South Pacific Economic Commission (SPEC) consulting with the SPC in the development of a 'co-operative and comprehensive'

regional environment programme (Carew-Reid, 1989, 69). Momentum continued through the 1970s with a number of programmes conceived and, to varying degrees, implemented.

For most PICs, contemporary involvement in the practice of multilateral environmental agreements began with the UN Convention on the Law of the Sea (UNCLOS), the agreement on Conservation and Management of Straddling Fish Stocks (CMS); and the UN Framework Convention on Climate Change (UNFCCC). Further linkages with global initiatives occur via the Convention on Combating Desertification and the Convention on Biological Diversity, particularly as it pertains to access to genetic resources (UNEP, 1999).

There are three main conventions in operation in the Pacific region. The first is the Convention on Conservation of Nature in the South Pacific. Known as the Apia Convention, it began as a draft text first circulated in 1975. A 1976 meeting saw delegates accept its principles and objectives. Only the Cook Islands and Fiji had acceded by 1989; three more acceded in 1990 (Australia, France and Samoa) and it came into force in June of that year; Tonga followed in 1991). The objective of the Apia Convention is the broad-based conservation of nature.

The second important agreement is the Convention for the Protection of the Natural Resources and Environment of the South Pacific Region. Known as the SPREP or Noumea Convention, it has two protocols, one regulating co-operation in 'Combating Pollution Emergencies', the other intended to prevent pollution by dumping. These two agreements complement each other in providing PICs with a foundation for national and regional environmental programmes.

The third agreement concerns the importation, transboundary movement and management of hazardous wastes in the region. Known as the Waigani Convention, it was introduced in 1995 and recently came into force (on the 21st of October, 2001) when Tuvalu ratified (Forum Secretariat, 2001). While there are a number of international agreements not signed by PICs, some of the principles of these form the basis or have been included in regional agreements. The SPREP Convention is consistent with the London Dumping Convention, and the Waigani Convention incorporates aspects of the Basel Convention. Figure 8 outlines the major regional conventions and

their PIC membership. Note the widespread support of the South Pacific Nuclear Free-Zone and the varied commitment to the three main regional 'agreements'.

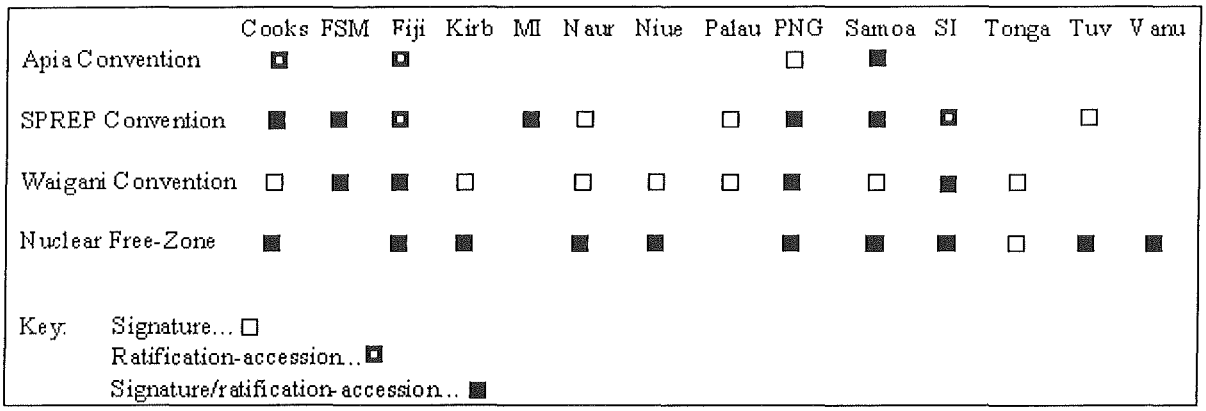

Fig. 6: PIC membership of main regional agreements (Source: UNEP, 1999, 35).

During the 1980s and in parallel with the activities of SPREP, some PICs developed their own environmental legislation, and most engaged directly in international treaty making programmes. However, few managed to establish institutional mechanisms within government administration to oversee environmental management (Wendt, 1992).

Regional agreements remain the key driving force for addressing issues of environmental management. In the area of climate change, the Pacific Islands Climate Change Assistance Programme (PICCAP) was designed to help those ten PICs that are parties to the UNFCCC meet their obligations under that Convention. Aided by SPREP, this programme commenced in 1997 and is funded by GEF. Phase II funding amounted to US$1 million; a scoping study for Phase III was financed by the government of Japan (Kaly and Pratt, 2000). PICCAP has several objectives: to prepare greenhouse inventories, identify mitigation strategies, report on vulnerability and resilience to climate change, develop national implementation plans for climate change policy, and to prepare 'national communications' regarding these issues (SPREP, 1998). These objectives make it an important programme for building PIC capacity for contemporary environmental management.

The most far-reaching policy for regional environmental policy is Agenda 21. Originating from the Rio Conference it is designed to 'address the pressing problems of today and also ... preparing the world for challenges of the next century' (SPREP, 1993, 2). Although not a legally binding agreement, Agenda 21 does reflect high-level political commitment. It has four sections, namely Social and Economic Dimensions, conservation and Management of Resources for Development, Strengthening the Role of Major Groups, and Means of Implementation.

Each of these has implications for PICs but special recognition of the problems of small island states is contained within Chapter 17, 'Sustainable Development for Small Islands', authored by noted Pacific scholar, William Clarke (Clarke, 1994b). It broadly addresses concerns by calling for the:

- Study of the interactions between development and the environment.
- Determination and monitoring of carrying capacity.
- Preparation of medium and long-term sustainable development plans.
- Review and reform of institutional arrangements.
- Implementation of sustainable development plans.
- Design and implementation of rational response strategies to address climate change and accelerated sea-level rise.
- Promotion of environmentally sound technology.

Funding for these goals has come from four sources, of which the GEF has been dominant. The International Development Association (IDA) is also important in its role of reallocating World Bank funds towards national environmental initiatives. Bilateral Overseas Development Aid (ODA) is still a substantial funding source that is required for sustainable development (the UN has set a target of 0.7% GNP for developed countries). Finally, regional and subregional banks are perceived to have a role in providing concessions and favourable terms for the above mentioned aims (SPREP, 1993).

A number of other programmes have been established, including the SPREP Small Grants Scheme (SSGS) which began in 1989, to provide resources for quick responses (initially for Environmental Impact Assessments (EIAs) and marine pollution problems). In 1991 this was extended to cover all aspects of environmental problems not covered by SPREP's annual programme. It can provide a team of experts if necessary, or use in-country skills where possible. National actions were to be guided primarily by National Environment Management Strategies (NEMS). This began with an ADB-funded programme for five selected PICs in 1990, and was later extended to other PICs through UNDP funding (UNEP, 1999). NEMS have been finalised and/or endorsed by some PIC governments, namely the Cook Islands, FSM, Fiji, the Marshall Islands, Nauru, the Solomon Islands, Tokelau, Tuvalu and Samoa. Others have NEMS in draft form (Kiribati and Niue) or an equivalent programme, such as Palau's Comprehensive Conservation Strategy, PNG's Strategic Plan, or Vanuatu's National Conservation Strategy (UNESCAP, 2000).

Compliance with agreements across the Pacific region is variable; the lack of capacity that afflicts all PICs is the main reason offered (UNEP, 1999). It has been argued that international conventions are less relevant for SIDS in the area of providing an operational framework than they are in providing management principles and protecting rights (Aston, 1999). At the 11th SPREP meeting it was recognised that PICs need to strengthen links and co-ordinate activities between themselves, IGOs and NGOs in order to effectively implement Agenda 21 (SPREP, 2001). Despite criticism, involvement in globally-initiated conventions and programmes has been instrumental in developing appropriate environmental policies for individual PICs, as well as promoting awareness of environmental interrelationships. The ratification of regional agreements has been posited as more successful than global agreements as greater consensus and support can be expected from countries with compatible cultural, geographic and economic circumstances (Andrews, 2001).

There remains a need for the consolidation of PIC environmental legislation. This can be extensive for some PICs, particularly those with a long colonial past such as Papua New Guinea that have 'remnants' of that past in their modern legislation. There is a strong case for promoting greater community awareness in the need for better environmental management;

this may be associated with integrating certain traditional 'laws' and practices. Finally, regional programmes have to be tailored for the needs and circumstances of individual PICs (SPREP, 1993).

4.3.2 PIC Capacity.

The limited participation of indigenous Pacific Islanders and the limited PIC focus was a criticism of early development policies of the 1960s and 70s (Crocombe, 1976; Fairbairn, 1976). Conferences were regularly scheduled in Australia or New Zealand, with 'expat' experts of these countries dominating proceedings (Carew-Reid, 1989). Venues are now regularly located in the Pacific Islands (and this is open to a cynical interpretation), but the predominance of European scientists continues (Barnett, 2000b).

Employing and retaining qualified staff across the region remains an ongoing problem for Pacific organisations. Concerns over staffing were expressed at the 11th SPREP Meeting following the tabling of a report on 'Job Sizing' and remuneration for CROP agencies. The review, undertaken by consultancy group Mercer Cullen Egan Dell, was intended to help develop a consistent approach across all CROP agencies. Using Australian Public Sector salaries as a baseline, it was received by delegates with caution, as was a recommendation to compare SPREP support staff contracts with Fijian salaries. Plans to conduct a 'market survey' of Samoan conditions - the base for the majority of SPREP's 70 to 80 staff - meant that plans to 'harmonise' employment conditions were deferred (SPREP, 2000).

PIC governments have found the reporting requirements of many regional and international commitments a strain on their human and financial resources. For example, at a regional workshop in 1998, only four of the 14 participating PIC's had completed their National Reports as required by the Convention on Biological Diversity (they were Cook Islands, Marshall Islands, Fiji and Samoa) (UNEP 1999).

Improvements have occurred. The number of staff employed by PIC governments in environmental management areas has increased from the beginning of the 1990s, as Table 4 shows.

Table 4: Environmental staffing levels in selected PICs (Source: Miles *et al.*, 1996, 127).

	1990	1995
Kiribati	1	2
Fiji	3	7
Palau	3	6
Solomons	4	5
Tokelau	1	5
Tuvalu	0	1
Vanuatu	3	8
Samoa	5	12

Despite these improvements, concerns remain. SPREP (1998) noted the 'limited amount and fragile state' of the data sets required for addressing climate change. The need for a baseline from which deviations can be observed and measured for the purposes of establishing causality and indicating mitigation strategies is a pressing issue in the Pacific region, and the capacity to undertake this task is uneven across the Pacific region.

In summary, PIC regional alliances are a result of seeking economies of scale, building on cultural and historical common experiences, and, despite the diversity of island environments noted in Section 1.1, common concerns are expressed regarding their island characteristics.

4.4 Pacific regional responses to vulnerability.

4.4.1 Development of responses.

The PIC response to transboundary environmental problems has necessarily involved foreign countries, multilateral agencies and NGOs who provide financial support, expertise, information and promote awareness at varying spatial scales. These organisations do not operate in either a funding or a policy vacuum. In fact it is apparent that they are highly dependent for support in both facets from larger organisations that generally operate at the global scale.

The contemporary PIC response to vulnerability issues has grown in an ad hoc manner. Organised disaster relief was evident early in colonial administrations, for example the Commissioner of Native Affairs in Fiji supplied food relief for some villages following a devastating cyclone in 1886 (McLean *et al.*, 1977). Such efforts were to become more comprehensive throughout the 20th century, but have tended to undermine traditional coping mechanisms (Campbell, 1997).

Various global and regional meetings have discussed issues of vulnerability for small island states and PICs have played an integral role. Momentum from the Rio Conference and Agenda 21 was continued with the Global Conference on the Sustainable Development of Small Island Developing States, held in Barbados in 1994. From Barbados came the Plan of Action that, among other issues, acknowledged concerns over the unique characteristics of island states that constrained their economies and threatened their continued viability. In the Pacific there has been widespread support for the development of an index of this type to reflect the unique aspects of island environments that hinder successful development.

4.4.2 The South Pacific Geoscience Commission and the EVI Project.

The origins and functions of the South Pacific Geoscience Commission (SOPAC) provide a useful insight into their role in contemporary environmental issues in the Pacific. SOPAC is

an independent, inter-governmental regional organisation. As mentioned above, its origins date back to 1972 when, under the United Nations Development Programme, the Co-ordinating Committee for Mineral Prospecting in South Pacific Offshore Areas (CCOP/SOPAC) was established. Reconstituted in 1984, and then again in 1989, it has 16 members: Australia, Cook Islands, Federated States of Micronesia (FSM), Fiji, French Polynesia (associate member), Guam, Kiribati, Marshall Islands, New Caledonia (associate) New Zealand, Papua New guinea (PNG), Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu. Reporting to the South Pacific Forum leaders, its Secretariat is based in Suva and has about 54 professional and support staff (SOPAC, 2001).

Fiji has exerted a degree of influence on the operations of SOPAC and this is often resented by other member countries (Crocombe, 2001). Most members wanted SOPAC's permanent headquarters located elsewhere, with Tonga being the preferred location. The then leader of Fiji, Ratu Sir Kamasese Mara, contrived to have the organisation remain in Fiji. In the regional politics of the Pacific mentioned in Section 4.3, SOPAC has not been immune.

SOPAC's stated mission is:

"to promote co-operation in the South Pacific region and to provide assistance in order to protect and improve its environment and to ensure sustainable development for present and future generations."
(SOPAC website, 2001).

This is somewhat different in subject and tone from SOPAC's Constitution...

"*...to promote, facilitate, undertake, coordinate, advise on, and cooperate in, the prospecting of and research into, the non-living resources in the offshore, coastal and onshore areas of those countries whose Governments are Members of the Commission as well as in other areas of the South Pacific;*

b) to otherwise assist in the development of such resources, and

c) to undertake such other activities related to prospecting, research and development of these resources as the Governing Council shall determine."

SOPAC (2001a)

There is no mention of 'sustainability' in this latter document.

SOPAC's annual budget is around F$9 million, and is sourced from member contributions, and by voluntary contributions from other sources. These other sources consist of supporting governments including Canada, France, Japan, Korea, the People's Republic of China, Taiwan and the US. The European Union, the Commonwealth Fund for Technical Cooperation, and UNDP are the main multilateral supporting agencies (Pratt *et al.*, 2001).

There are two categories of funding. The first is the 'General Purpose Fund' that is earmarked for management, financial and administrative services, as well as the maintenance of equipment, databases and information services. It is primarily comprised of member countries' donations. The second is the 'Special Purpose Fund' for all other programmes and projects and is primarily made up of funding from outside donors (SOPAC, 1994). The allocation of funds between five core activities is listed in Figure 10.

Table 5. Allocation of SOPAC funds; 1995 and 1999 (% of total funding). (Source: SOPAC, 1994, no page).

	1995	1999
Mineral and Energy Resources	20%	18%
Environmental Geoscience	26%	35%
Capacity building	17%	13%
Technical Services	16%	16%
Corporate Services	21%	18%

SOPAC have a number of projects and programmes underway. They include an ongoing Geographic Information Systems and Remote Sensing (GIS/RS) programme, the Small Island Water Information Network (SIWIN), a project concerned with Tuvaluan internet connectivity (Tuvalu ISP), and the Wide Area Geographic Information System (WAGIS) that revolves around the collection and analysis of regional 'metadata'.

The EVI project is staffed by a team of five full time researchers, comprising two environmental scientists, two economists, and a biostatistician. Four additional support staff include another environmental scientist, another economist, a geo-ecologist and a marine geologist (SOPAC, 2001a). Since August 1998 this team has been engaged in the development and refinement of proxy measures of environmental dimensions, and a methodology to arrive at a single-figure 'score' that accurately reflects the environmental vulnerability of a state, region or island.

The EVI has several intended purposes. Primarily it is an attempt to incorporate measures of ecological 'integrity' which can subsequently be merged with economic indices to form a Composite Index that will more fully communicate the vulnerability of small island developing states. Other purposes include:

- To assist in the determination of Less Developed Country (LDC) status. The need for greater awareness by officials and aid agencies on environmental issues affecting small states in general and islands in particular (Commonwealth Secretariat, 2000). The LDC status of two PICs (Vanuatu and Samoa) was to be negotiated around the time the EVI was undergoing provisional testing.
- To provide a performance indicator for aid. Concerns over the effectiveness of various aid programmes in the Pacific region have been voiced (Callick, 1993). However, aid is very much a diplomatic 'tool'. In the Pacific this has seen relatively small nations, some of which are micro-states, extend official support in various international fora for such 'causes' as the Japanese whaling industry, and the quest by Taiwan for international recognition. This latter phenomenon is countered in many respects by Chinese aid, which

is also a reflection of that countries competition with Japan for influence in the Pacific region (Crocombe, 2001).

- To help identify where internal intervention and external assistance is needed. The national and international response to environmental problems is a problematic area as many indigenous Pacific Islanders view their own and foreign governments with suspicion (see Sections 3.2.1 and 3.3.1). Any programmes of this kind would be subject to influence of the kind noted on aid indicator.
- To contribute to State of the Environment (SOE) reporting. As Section 4.3.1 showed, many PICs have already completed or substantially adopted some form of SOE reporting.
- To help identify and mitigate hazards. This is potentially a very useful function of an Environmental Vulnerability Index for the Pacific region. The usefulness of the EVI for this objective will be dealt with in Chapter 6.
- To act as a sustainable development tool. Another potentially useful function for this index in the Pacific region, implicitly already present in any attempt to monitor the property of resilience in the environment (Dovers, 1997).

(Kaly *et al.*, 1999b, 11)

The lack of capacity that PICs have for effective environmental management has been noted (UNEP, 1999). SOPAC consider the EVI project helps to rectify this constraint on PIC governments by seeking, identifying, and collating data relevant to the EVI (Craig Pratt, pers. comm.).

SOPAC acknowledges that ecological integrity is a complex concept dependent upon biodiversity, ecosystem functioning and resilience. These are interrelated variables that will require a number of indicators at different spatial, temporal and hierarchical levels of ecosystem organisation (Kaly *et al.*, 1999a). The method of using indices to assess and monitor environmental issues has been used for other projects in the Pacific. SPREP has established a number of biological and socio-economic indicators to monitor the progress of Conservation Areas in the South Pacific. These biological indicators are to measure the success of preserving biological diversity and the socio-economic indicators reflect the impact of the programme on communities living in the area being surveyed (Sesega, 2000). With the

SOPAC EVI project, a far more ambitious attempt is underway to quantify environmental or ecological 'quality'. Beginning with work in the Pacific, it is now being developed to be universally applicable (Kaly *et al.*, 1999a). An understanding of the process undertaken by SOPAC in the development of an Environmental Vulnerability Index (EVI) will be critical to the interpretation of EVI results. While work on the EVI is still progressing, enough information exists to reach conclusions on its form and expected functioning. This is undertaken in two parts: a description of the individual indicators in the next chapter, and a critical overview of the EVI model in Chapter 6.

4.5 Conclusions

The establishment of environmental IGOs and NGOs, and the development and implementation of their policies, informs a major part of contemporary environmental management. Although the largest of these organisations have considerable input, in the developing world significant constraints exist with regards to policy, administration, funding and technical capacity. 'Western' science is also organised into formal bodies that are explicitly involved in framing environmental policy and legislation, in some instances actually driving the process. While objectivity is often proclaimed by scientific communities, their involvement in environmental management necessarily includes more subjective factors associated with bureaucratic decision-making and administrative procedures at the local, national, regional and global level.

International 'norms' have emanated from such well-publicised events as the Stockholm and Rio conferences. For the Pacific co-operation is occurring around common concerns, and the means to do this have primarily been formalised at the regional scale. The environment has only recently been of importance in Pacific regional co-operation, and its growing relevance has been evident with the development of many national programmes. Although individual PICs have passed legislation compliant with many international conventions, the necessary 'action plans' originate with specific global and regional programmes, of which Agenda 21 and the Barbados Plan of Action are the most relevant for contemporary PIC management.

PIC action to mitigate the effects of environmental hazards and disasters has been a component of the wider responses of island states. SOPAC's Environmental Vulnerability Index project brings into play the processes of several organisations, including global agencies, national governments and NGOs, and is an attempt to measure the problematic concept of ecological integrity.

Chapter Five: The Environmental Vulnerability Index Project

The preceding chapters have described the management context and the role of environmental science in informing environmental management in the Pacific region. PICs experience benefits and constraints in area of formulating and implementing effective environmental management. The benefits stem from coordinated attention and the provision of funding by global organisations; the constraints are continuing limited capacity and the fragmentation of governance. It is in this context that efforts by SIDS to assess, monitor and communicate their environmental vulnerability take place. This chapter will describe in detail the process by which one Pacific organisation, namely SOPAC, has attempted to quantify these concerns with their development of an Environmental Vulnerability Index (EVI). A more general critique will be undertaken in Chapter 6; the aim of this chapter is to describe the selected indicators, the rationale for their selection, and anysome associated problems.

5.1 Development of the EVI.

The first mention in an international forum of a need to develop an environmental vulnerability index came from the Maltese ambassador at a 1990 UNCTAD meeting on the problems faced by Small Island Developing States (Kaly *et al.*, 1999a). Efforts to define and *measure* these environmental factors originated with work done by the Caribbean Development Bank (Keneti Faulalo, pers. comm.). The focus was economic and sought to quantify factors such as smallness, isolation, and the occurrence of natural disasters that impacted negatively on island economies.

The 1994 Barbados Plan of Action (Section 4.4.1) further advanced debate for the need of such an index. One of the outcomes was a specific call for the development of an index to measure the physical aspects of this vulnerability. This is articulated in paragraphs 113 and 114;

113. *Small Island Developing States, in co-operation with national, regional and international organisations and research centres, should continue to work on the development of vulnerability indices and other indicators that reflect the status of SIDS and integrate ecological fragility and economic vulnerability. Consideration should be given to how such an index, as well as relevant studies undertaken on SIDS by other international institutions, might be used in addition to other statistical measures as quantitative indicators of fragility.*

114. *Appropriate expertise should continue to be utilised in the development, compilation and updating of the vulnerability index. Such expertise could include scholars and representatives of international organisations that have at their disposal the data required to compile the vulnerability index. Relevant international organisations are invited to contribute to the development of the index. In addition, it is recommended that the work currently under way in the United Nations system on the elaboration of sustainable development indicators should take into account proposals on the vulnerability index.*

(cited in Kaly *et al.*, 1999a, 13).

A subsequent Expert Group Meeting, convened by the SIDS Unit of the United Nations Department of Economic and Social Development (UNDESD) in December 1997, failed to reach a solution that adequately addressed the Barbados Plan of Action. Instead it was agreed to retain economic parameters to measure SIDS vulnerability, while agreeing to continue efforts at developing an environmentally sensitive index (Kaly *et al.*, 1999a, 44).

New Zealand, in its role as Chair of the Commission for Sustainable Development (CSD), indicated its support for such an index in the Pacific. The initiative was supported by UNDP at a subsequent PIC Partners Meeting in July, 1998, where Forum Economic Ministers also agreed to adopt a common objective to develop an index that could be adopted by the UN. It was considered that such an index would be of use in determining Less Developed Country (LDC) status, and for deciding eligibility for concessional aid and trade treatment (Kaly *et al.*, 1999a, 45).

A Commonwealth Ministerial Mission to the World Bank and the International Monetary Fund (IMF) established a Task Force for Small States on July 13th, 1998, to study the legal, environmental and economic vulnerability of small states not currently eligible for established funding. This led to a SOPAC 'study team' being assembled in 1998 to develop a methodology to determine the environmental dimensions of this vulnerability.

Funded by New Zealand, this team released its first report in February, 1999 (Kaly *et al.*, 1999a). This report, summarising Phase I of the project, undertook a preliminary calculation of environmental vulnerability for three nations: Australia, Fiji and Tuvalu. It found that Tuvalu was the most vulnerable, the value obtained for Fiji was intermediate, and Australia was the least vulnerable (see Table 6). The characteritics of this vulnerability were different for each country: degradation was found to be greatest in Australia, and Tuvalu had the lowest 'intrinsic resilience'.

Other features of Phase I were the forging of useful links with other Pacific organisations and initial moves to improve capacity for PICs to contribute to the project. Development of the means of calculating a final, single figure 'score' from the collated indicators also began (see Section 5.4.1.). Phase I also involved presenting the project at various regional meetings, international workshops and PIC missions (Kaly *et al.*, 1999a).

Phase II began with a Think Tank, held in Fiji, September 1999. This meeting had three aims: i) to obtain commentary from experts in a range of fields that were considered relevant to the EVI; ii) to 'render the EVI acceptable and/or operational in the international community'; and iii) to identify areas for future work (Briguglio *et al.*, 2000, 7). Twenty experts from various disciplines were invited to engage in 'critical peer review' of the EVI project. A number of changes to the EVI took place following this meeting, most notably the reduction in the total number of indicators, from an original 57 to 47. Definitions were further refined, and a number of weighting options considered. Perhaps the most significant development was that the decision was made to 'globalise' the EVI: from Phase II on it was considered necessary that the index should be applicable

to all countries. Prior to this decision, the project had primarily been promoted as a Pacific programme.

A second experts meeting took place, this time in conjunction with UNEP and the Islands and Small States Institute, based at the Foundation for International Studies, University of Malta. This was held in Valletta, Malta, from 29th November to the 3rd December, 1999. This was the most important of many meetings where the EVI was presented and discussed, and involved considerable feedback that was incorporated into further refining of the indicator list and definitions.

The EVI project is currently in Phase 3 of its development. Figure 7 outlines the broad features of the development of the EVI project, including the main parties to which it has been presented and the principle funding sources.

Year	Phase	Main Features	Principle presentations	Funding
July 1998	Phase I	Initial framework and methodology Provisional data collected for Australia, Fiji, Tuvalu. SOPAC Technical Report 275	CROP ForumSec/SPREP SIDS CSD7 AOSIS Pacific Science Congress Forum Economic Ministers IDNDR PICCAP UN/SIDS UNEP SPTO Plus various country missions	NZODA
Feb 2000	Phase II	Fiji Think Tank Malta Meeting Prototype EVI Calculator EVI profiles for several Caribbean nations On-going PIC capacity building SOPAC Technical Reports 299 & 306.	Commonwealth Sec/World Bank UN Committee on Development Policy CSD8 PI News Ass. SOPAC Annual Session UNEP Continuing country missions.	NZODA
Dec 2000	Phase III (completed)	EVI profiles for several PICs. SOPAC Misc. Report 405	UNEP Continuing country missions.	Govts. of NZ, Ireland and Norway.
	Phase III (in progress)	EVI profiles for 15 varied countries.		

Fig. 7: Development of the Environmental Vulnerability Progress.
(Source: Pratt *et al.*, 2001)

So far provisional results have been published for only 5 countries, one of which (Australia) subsequently withdrew from Phase II of the testing of the model. These are shown in Table 6. Different weighting methods were tested and resulted in little change for Fiji, Samoa and Tuvalu but a dramatic change for Vanuatu. SOPAC were unable to

say whether this change was 'real' ie attributable to the weighting method being more accurate, or due to the combination of missing data (only 33 indicators were answered for Vanuatu; see Fig 8) (Kaly and Pratt, 2000, 22).

Table 6: Provisional results of EVI testing (Source: Kaly *et al.*, 1999a, 32; Kaly and Pratt, 2000, 22-26). The higher the score, the greater the vulnerability, scale 1-7.

Country	EVI Score	
	Phase I	Phase II
Australia	3.04	
Fiji	3.79	3.3
Samoa		3.4
Tuvalu	5.04	4.5
Vanuatu		3.1

The model used by SOPAC can be divided into two parts; i) the framework, consisting of the logic and mathematical method for calculating the index, and ii) the indicators and their weighting or 'imprtance' in relation to the overall EVI model.

5.2 Framework.

The EVI is framed by the original brief from the Barbados Plan of Action. This acknowledges that human systems and the environment are 'dependent' on one another: risks to the environment of a state will translate into risks to humans because of the dependence on the environment for resources (cited in Kaly *et al.*, 1999b, 1). Likewise, the environment is 'susceptible' to human activities and management strategies. Thus it is considered important to ascertain the 'state' of a country or regions environment irrespective of human values. In this respect, SOPAC acknowledges that the EVI is just one step in describing the overall vulnerabilities of a state, whether results are presented separately or combined with other indices (Kaly *et al.*, 1999b, 2).

SOPAC have adopted the following definitions for the purposes of developing the EVI (Kaly *et al.*, 1999b, 12)

The *natural environment* is defined as those biophysical systems that are capable of being autonomously sustained without human inputs;

Vulnerability is defined as proneness of the natural environment to damage and degradation;

Resilience is defined as the potential for a system to minimise or absorb the effects of damage;

Damage was defined as the reduction of diversity, extent, quality and function of natural environments, which may be reversible;

Degradation was defined as irreversible damage.

5.2.1 Sub-indices

SOPAC have grouped their indicators in two ways (UNEP/SOPAC, 1999, 10). The first consists of three sub-indices comprising:

1. The Risk Exposure sub-index (REI), measuring the frequency and intensity of those 'external forces' acting on the environment under consideration, including anthropogenic factors. This is generally based on observations of 5-10 years, but does include longer periods for geological events. There are 27 indicators of this risk.
2. Intrinsic Resilience sub-index (IRI), referring to the 'innate ability' of 'natural systems' to maintain their integrity when subject to disturbance. SOPAC have concentrated on broad indicators allowing an approximate measure at the scale of entire states. There are seven indicators of this 'intrinsic' resilience.
3. Environmental Degradation sub-index (EDI). This is intended to indicate the ability of ecosystems to maintain their integrity after suffering past negative impacts. It is assumed that the greater the number and intensity of historical impacts – natural or anthropogenic - the greater the vulnerability to *future* stresses will be. There are 13 indicators of this degradation.

Consideration was given to combining the IRI and EDI as a result of discussions at the Fiji Think Tank. However, SOPAC have continued with the attempt to differentiate between what they term *intrinsic* (IRI) and *extrinsic* (EDI) resilience. Environmental vulnerability is the sum of these three sub-indices.

5.3 Indicators

5.3.1 Categories.

In addition to the three sub-indices, five categories of risks to the environment are recognised. SOPAC have definined 'risk' as 'any event or process that can cause damage to the environment' and includes natural and human events and processes. The categories are described below:

i) Meteorological (M). Indicators in this category are intended to capture the risks to the natural environment of the following phenomena: cyclones, storms, surges, droughts, floods, heat waves and cold snaps, the ENSO phenomenon, and tornadoes (Kaly *et al.*, 1999a, 19). This category is represented by six indicators in the EVI.

ii) Geological (G). Indicators in this category are intended to be proxies for landslides, subsidence, erosion and accretion, and altered tidal ranges (Kaly *et al.*, 1999a, 19). This category is represented by three indicators, they are measures of the frequency and magnitude of earthquakes, tsunamis and volcanoes.

iii) Biological (B). A category which is comprised of a range of measures based around various species whose presence or numbers are indicators of either 'risk' (such as pathogens) or degradation (eg intensive farming). There are eight indicators in total for this category.

iv) Anthropogenic (A). Indicators in this category are intended to be proxies for the exploitation of resources, the destruction of habitats, human population pressures, inappropriate environmental management and inappropriate development (Kaly *et al.*, 1999a, 19). This is the largest category, represented by 23 indicators.

v) Country Characteristics (CC). This category has seven indicators, all of which are in the Intrinsic Resilience sub-index, that are intended to represent a countries inherent 'natural' ability to assimilate negative impacts.

A number of indicators have been suggested, debated and discarded during the development process, and the precise wording has undergone much revision following the two Think Tanks. Many of the original indicators were replaced, and the wording or descriptions altered for others. Various mathematical variations were discussed but no final decision on methodology was made. 'Scoring' for each indicator is on a 1 to 7 scale, with 'most vulnerable' status given a seven, and 'least vulnerable' one, with quantified gradations in-between. This enables the heterogeneity of environmental indicators to be simplified, that is variables for which the responses are numerical, qualitative and on different scales (linear, non-linear, and with different ranges) are reduced to a standard common scale (see Section 5.4 to see how this works in practice). Those indicators that are not applicable to a country are to be scored as a 1 on the scale. Provisionally set during Phase II, the mapping of responses has been further modified following the Malta meeting although again methodology has not been finalised. For the purposes of this index, SOPAC have decided that 80% of indicators are required in order to reach a 'valid' EVI score. This requirement was suggested during the Fijian Think Tank and adopted without further discussion (Kaly *et al.*, 1999b, 31). They have also suggested a 5 yearly review of the EVI once it is operational.

5.3.2 Weighting

The 'weighting' of indicators has also received much attention. The purpose of weighting is to identify those indicators which are most important to any measure of vulnerability and ensure that their 'signals' in contributing to the EVI are 'larger' than less important indicators (Kaly and Pratt, 2000, 13). Discussions at the Malta meeting led to the 47 indicators being rated in perceived importance by the 15 experts on a scale ranging from 0 to 4, with zero indicating no importance (meaning the indicator should be discarded) and 4 indicating the highest importance. The values obtained were averaged over all of the Think Tank participants, and the final score for each indicator used to assign a low,

medium or high weighting to each. Of the 47 indicators, 15 were assigned high, 18 medium, and 14 low weight. The effect of this weighting on the calculation of indicator scores, and thus the overall EVI result, occurs via the EVI Calculator, a software package being developed by SOPAC for this project (see Section 5.5).

Participants at the Malta meeting agreed that it is not possible to use weights derived on the basis of ecological criteria alone, and some subjectivity would have to be tolerated in this regard. Indicators are weighted in terms of their *perceived importance by the experts* associated with the compilation of the index. It was agreed that ultimately it will be the responsibility of the experts compiling the index to choose the appropriate weighting, based on plausible criteria and following extensive consultation (Briguglio *et al.*, 2000).

5.4 Indicator list: Descriptions, weighting and scoring.

A brief discussion of each of these categories and their indicators follows, including their 'history' when this is considered relevant, and a brief discussion of their usefulness or otherwise for PICs. Indicators are listed in order and grouped into the five categories Meteorological (M), Geological (G), Biological (B), Anthropogenic (A) and Country Characteristics (CC). The sub-index is noted, that is whether the indicator reflects an external risk (REI), internal resilience (IRI) or degradation that effects future coping ability (EDI). The main proxy factors that each indicator is attempting to 'capture' are also listed. The actual wording used in the EVI is in italics; weighting categories of high (H), medium (M), or low (L) are in parentheses. The schema below each description shows how the seven point scale is related to the measurements in the appropriate units.

5.4.1 Meteorological Indicators.

No.

1. Sea surface temperature (REI): *Greatest average annual deviation in surface sea temperature during last 5 years, from long term average (using a 30 year average).* (M).

   This indicator reflects impacts on wind patterns, coral bleaching, fisheries and general environmental stress as well as ENSO effects and cyclone formation. These impacts are considered too indirect for landlocked countries, and is not intended to apply for countries lacking a coastline. Discrepancies between data compiled locally by different countries and the more widely available data of the National Oceanic Atmospheric Agency (NOAA) means the latter will be used. However, there is a complete lack of data for PICs to answer this indicator (see Fig 10).

1	2	3	4	5	6	7	Units
0				> 0 - 1	> 1	> 2	Degrees

2. High winds (REI): *Number of days over the last 5 years during which the maximum recorded wind speed (3 sec gusts) was at least 20% higher than the average maximum for that month (use a 30 year average for each month as reference, and average the results over all reference climate stations).*(M).

   A proxy for cyclones, tornadoes, storms and erosion, this indicator is a merger of two earlier indicators that measured the number of cyclones and the severity of storms; this simplifies the EVI model and allows application globally. Like No.1, this indicator has a "Medium' weighting, yet for PICs these two indicators measure highly relevant proxies.

1	2	3	4	5	6	7	Units
0	1 - 10	11 - 20	21 - 30	31 - 40	41 - 50	> 50	Days

3. Dry periods (REI): *Number of months over the last 5 years during which rainfall was at least 20% lower than the 30 year average for that month (use a 30 year average for each month as reference, and average the results over all reference climate stations).* (M).

   Chosen to indicate drought risk and risks to freshwater resources, important threats to small coral atolls.

1	2	3	4	5	6	7	Units
0 - 5	6 - 10	11 - 15	16 - 20	21 - 25	26 – 30	> 30	Months

4. Wet periods (REI): *Number of months over the last 5 years during which rainfall was at least 20% higher than the 30 year average for that month (use a 30 year average for each month as reference, and average the results over all reference climate stations).*(M).

   Intended to indicate the risk of floods and effects such as turbidity of coastal waters, pollution and erosion. Various proxies have been suggested to capture the effects of variable rainfall, some of which have been incorporated into other indicators (e.g. No.28, loss of natural vegetation).

   It has been noted that floods can and do have positive effects on the environment, that while they destroy some habitats they create others. SOPACs position is that any kind of rapid change in ecological quality and/or the way humans used the environment would constitute 'harm' to that environment.

1	2	3	4	5	6	7	Units
0 - 5	6 - 10	11 - 15	16 - 20	21 - 25	26 - 30	> 30	Months

5. Heat waves (REI): *Number of days over the last 5 years during which the maximum temperature was at least 5 ^{0} C higher than the mean monthly maximum for that month (use a 30 year average for each month as reference, and average the results over all reference climate stations).*(M).

Like No.3, considered a proxy for freshwater resources, it also captures desertification processes and temperature stress.

1	2	3	4	5	6	7	Units
0 - 10	11 - 20	21 - 30	31 - 50	51 - 70	71 - 80	81 - 100	Days

6. Cold snaps (REI): *Number of days over the last 5 years during which the minimum temperature was at least 5^0 C lower than the mean monthly minimum for that month (use a 30 year average for each month as reference, and average the results over all reference climate stations).*(M).

   A proxy for temperature stress.

1	2	3	4	5	6	7	Units
0 - 10	11 - 20	21 - 30	31 - 50	51 - 70	71 - 80	81 - 100	Days

Indicators 2-6 were originally to use a 100 year period to capture the long term trend. The Malta meeting decided this could create data problems and following discussion it was agreed that the benchmark of a 'once in 100 year event' would be changed to deviations from a 30 year average.

5.4.2 Geological Indicators.

7. Volcanic eruptions (REI): *Number of volcanoes (with potential for eruption) having a Volcano Explosivity Index equal or greater than 4. The result to be expressed as a ratio of land area. (Volcanoes situated within 100 km of country land boundary).*(M).
Originally "the number of volcanoes with potential for explosive eruptions/ 10,000 sq. km. Land area", this was modified to incorporate the Volcano Explosivity Index. VEI-4 is a cataclysmic volcano with plume height of 10-25 km, and lava and/or ash volumes of 100 million m^3. Also a proxy for landslides, geysers, gas, fires, ash, dust and marine kills.

1	2	3	4	5	6	7	Units
0			1 - 2	3- 4	5	> 5	No./km^2

8. Earthquakes (REI): *Earthquake energy with ML >=6.0 and <=15km depth over the last 5 years. (The earthquake energy occurring 100 km of country land boundaries). The result to be expressed as a ratio of land area.*(L).
The ML or Magnitude Local scale is equivalent to the Richter scale, and measures 'the magnitude of an earthquake as the logarithm of the amplitude of waves recorded by seismographs, adjusted for variation in the distance between seismographs and the epicentre' (Kaly and Pratt, 2000, 72).

Original wording was considered too vague as it did not consider depth. The division by EEZ instead of land area was mooted but ultimately it was decided that the inclusion of underwater earthquakes within 100km of country boundaries related to land area was justified as this was where the most significant environmental changes were thought to take place. Also a proxy for landslides.

1	2	3	4	5	6	7	Units
0			1 -2	3 - 4	5	> 5	No./km^2

9. Tsunamis (REI): *Number of tsunamis or storm surges with run-up >2m above MHWS/ 100km coastline, since 1900.* (L).

   Indicates the risk of habitat disturbance and organism kills as well as the more obvious associated disaster impact. Problems with defining and measuring 'coastal area' led to the decision to relate all indicators referring to this to the length of coastline. The inclusion of storm surges is thought to improve the global application.

   As worded, this indicator relies on accurate historical data on tsunamis which may not exist.

1	2	3	4	5	6	7	Units
0			1 - 2	3 - 4	5	> 5	No./100 km

These three indicators represent 'classic' environmental hazards of infrequent but possibly devastating effects.

5.4.3 Country Characteristic Indicators.

10. Land area (IRI): *Total land area km^2.* (H).

    Indicates 'richness' of habitat types and refugia. Debate at the Malta meeting raised the political implications of using an indicator that is so clearly biased in favour of small countries. However, it was considered that for technical reasons of ecological functioning, diversity, extent and persistence, this be retained.

1	2	3	4	5	6	7	Units
>1,000,000	100,001 – 1,000,000	10,001 – 100,000	5,001 – 10,000	1,001 – 5,000	100 - 1,000	< 100	km^2

11. Fragmentation (IRI): *Length of ocean shoreline or landed border divided by total land area.* (H).

    A key indicator for most PICs, primarily because of the greater exposure to risks impacting upon the coastal zone. Many PICs, particularly those comprised primarily

of atolls such as Kiribati and Tuvalu, consider this aspect of their environment to be the most relevant factor in their vulnerability to climate change.

1	2	3	4	5	6	7	Units
0	> 0 – 0.1	0.1 – 0.5	0.6 - 1	1.1 – 1.5	1.6 - 2	> 2	km/km^2

12. Isolation (IRI): *Distance to nearest continent within 10 degrees latitude (km).* (L).

This is a proxy for proximity to refugia and biodiversity, as well as opportunities for 'recolonisation' for some species. A problematic indicator due to varying interpretations of what a 'continent' is. While noting for the purposes of the EVI that Australia is the smallest continent, SOPAC acknowledge that this term needs to be defined as precisely as possible in order to be consistent. For SIDS this is a key indicator, as isolation is one of the primary factors contributing to both their economic volatility and their environemtnal vulnerability. However, this measure - proximity to a continent - does not accurately portray species colonisation which has occurred by island hopping along the chain of islands spreading out from Southeast Asia, and by human activity (whether intentional or unintentional).

1	2	3	4	5	6	7	Units
0	> 0 - 500	501 – 1,000	1,001 – 1,500	1,501 – 2,000	2 ,001 – 3,000	> 3,000	Km

13. Vertical relief (IRI): *Altitude range (Highest point - lowest point in country).* (M).

A proxy for ecosystem and species diversity.

1	2	3	4	5	6	7	Units
> 3,000		2,001 – 3,000	1,001 – 2,000	101 – 1,000	11 - 100	< 10	m

14. Lowlands (IRI): *Percent of land area < 10m above sea-level.* (H).

Originally defined as below 20 metres, this is intended to indicate the risks of flooding and areas where pollution might accumulate; also a proxy for ecosystem

diversity, although it primarily describes vulnerability to tsunamis, sea-level rise and flooding.

1	2	3	4	5	6	7	Units
0	> 0 - 2	2.1 - 4	4.1 - 5	5.1 - 10	10.1 - 20	> 20	%

15. Coastal vulnerability (IRI): *Percentage of land area <10m elevation within 2km of coast composed of unconsolidated sediments (excluding coral reefs and ice).* (M).

A measure of the risks of storm surges, cyclones and erosion. Whether 'unconsolidated sediment' is an appropriate proxy for impacts from hazards was discussed at the Malta meeting. Undoubtedly a key concern for small island states, this will prove difficult to measure.

1	2	3	4	5	6	7	Units
0	> 0 – 2	2.1 - 4	4.1 - 5	5.1 - 10	10.1 - 20	> 20	%

16. Endemic species (IRI): *Number of known endemic species / sq km land area (multiply result by 1,000).* (H).

A measure of species that occur exclusively in the country and nowhere else. Although an obvious indicator to include, it does raise interesting questions as to what is endemic and where exactly a species needs to inhabit to be included. The vast array of marine species remain largely unclassified, as do many invertebrate species of tropical forests. The lack of data held on the endemic species of developing countries will hinder valid recording of their number for the purposes of biodiversity measures.

1	2	3	4	5	6	7	Units
0	> 0 - 10	11 - 30	31 – 50	51 - 70	71 - 1000	> 100	No./km^2

5.4.4 Biological Indicators.

17. Pathogens and plagues (REI): *Number of reported and verified organism outbreaks over the last 5 years/ land area (multiply result by 1,000).* (M).

Another term that needs further definition. Measurement will require increased capacity in PICs. Quantifying epidemics and outbreaks in the developing world is difficult as the current dengue outbreak in some PICs reveals. There is confusion over whether some

dengue outbreaks in the Solomons' and PNG have been classified incorrectly as malaria, reducing the reported incidence of dengue (which has a different vector but similar symptoms) (West Pacific Regional Office, 2000). Also, there is evidence that dengue is subject to cyclic recurrence which may be 'missed' by the 5 yearly assessment that SOPAC has put forward for the EVI.

1	2	3	4	5	6	7	Units
0	> 0 - 10	11 - 30	31 - 50	51 - 70	71 – 100	> 100	No./km^2

18. Potential for introductions (REI): *Total tonnage of freight imported/ year/ sq km land area.* (M).

    While this proxy is restricted solely to commercial shipping, any influx of tourists must also be considered a source of possible introductions. The various islands in an archipelago will face differential risk according to physical characteristics and transport links.

1	2	3	4	5	6	7	Units
0	> 0 - 100	101 - 200	201 -300	301 - 400	401 - 500	> 500	T/km^2/yr

19. Introductions (EDI): *Number of all introduced species/ km^2 land area since 1900 (multiply result by 1,000).* (M).

    It is accepted by SOPAC that for defining this and the following two indicators the most recent definitions as used by the International Union (IUCN) will be used where appropriate. Considering this measure as a proxy for a country's 'vulnerability' is challenged by the economically and nutritionally valuable contribution made by a number of important species, such as pumpkin in Tonga, dairy cattle in Fiji and Cassava (originally from Brazil) across the region.

1	2	3	4	5	6	7	Units
0	> 0 - 100	101 - 200	201 -300	301 - 400	401 - 500	> 500	No./km^2

20. Endangered species (EDI): *Number of endangered and threatened species/ km^2 land area (multiply result by 1,000).* (H).

    A species is considered 'endangered' for the purposes of the EVI when it faces a very high risk of extinction in the wild in the near future. SOPAC are including the IUCN

category of 'Critically Endangered' in this indicator, defined as those species facing an *extremely* high risk of extinction. In the Pacific, certain endangered species, most notably the turtle, the dugong, and a species of bat are traditional dishes and still prized in some quarters.

1	2	3	4	5	6	7	Units
0	> 0 - 100	101 - 200	201 -300	301 - 400	401 - 500	> 500	No./km^2

21. Extinctions (EDI): *Number of species which have become extinct since 1900/ 10,000 km^2 land area (IUCN definitions) (multiply result by 1,000).* (H).

A species is considered extinct when 'exhaustive surveys' in known or expected habitats fail to record an individual.

1	2	3	4	5	6	7	Units
0	> 0 - 1	1.1 - 2	2.1 - 5	5.1 - 8	8.1 - 10	> 10	No./km^2

22. Natural vegetation (EDI): *Percentage of natural and regrowth vegetation remaining (eg forests, mangroves, saltmarshes, prairies, savannah, desert, tundra).* (H).

A problematic indicator for landscapes with a long history of human-nature interaction. Conceptualising 'natural' vegetation in environments that have experienced long-term human use is problematic. For many Pacific communities the distinction natural and utilised forest is irrelevant and even nonsensical (Olsen, 2001).

1	2	3	4	5	6	7	Units
> 80	61 - 80	41 - 60	31 - 40	21 - 30	11 - 20	0 - 10	%

23. Intensive farming (EDI): *Tonnage of intensively-farmed animal products/year/ km^2 land area (includes aquaculture, pigs, chickens etc)* (L).

For the EVI, intensive farming includes all farming practices for which waste products cannot be 'largely attenuated' over the land area on which they are produced (Kaly and Pratt, 2000, 72). The international standard is now tonnage of livestock rather than number, which was the form the data supplied to generally took SOPAC. A conversion rate of 2kg per chicken or duck and 100 kg for pigs was undertaken.

1	2	3	4	5	6	7	Units
0	> 0 - 1	1.1 - 2	2.1 - 5	5.1 - 8	8.1 - 10	> 10	T/km^2/yr

24. Fisheries (EDI): *Percent of fisheries stocks overfished (FAO).* (H).

Various attempts were put forward during the development of the EVI to capture the vulnerability of fisheries, eg the number of commercial vessels, enforcement and regulation attempts, even the use of destructive methods (discarded once the decision to globalise the EVI was made as it was considered too specific to PICs). Ultimately it was decided to utilise FAO definitions.

There are problems of defining 'ownership' of migratory fish species such as the various species of tuna, catches of which dominate commercial fisheries in Pacific waters, albeit under foreign flags.

1	2	3	4	5	6	7	Units
0		> 0 - 20	21 - 40	41 - 60	61 - 80	81- 100	%

5.4.5 Anthropogenic Indicators.

25. Coastal settlements (EDI): *Density of people living in coastal settlements with city centre within 20 km of coast (people per sq km land area).* (H).

Further work on defining the denominator for this indicator is acknowledged. This indicator represents yet another key SIDS concern. It assumes that coastal settlements are somehow more damaging to the environment than those located inland, and is perhaps not as 'sensitive' a measure as the per centage of population who are urban dwellers.

1	2	3	4	5	6	7	Units
0 - 20	21 - 40	41 - 60	61 - 80	81 - 100	101 - 200	> 200	No./km^2

26. Human population density (REI): *Total human population density (per km^2 land area).* (H).

Testing thus far reveals an *exact* correlation for PICs between this and the above indicator (Kaly and Pratt, 2000, 47). This indicator is weighted 'high', whereas No.29, measuring tourists' is rated 'medium' which appears to consider *a priori* that

locals will have a more deletorious effect upon the environment than visitors (see Indicator No.29 and Section 6.2.5).

1	2	3	4	5	6	7	Units
0 - 20	21 - 40	41 - 60	61 – 80	81 - 100	101 - 200	> 200	No./km^2

27. Human population growth rate (REI): *Annual human population growth rate (percent) (average over last 5 years).*(H).

There is not a direct relationship between population growth and negative environmental impacts. Problems arise due to a lack of effective policies and infrastructure to treat the results of increasing human activity, such as waste and unsustainable resource use. These factors are acknowledged in other indicators, for instance no.s 30, 31, and 32 that capture wastes products and their treatment.

1	2	3	4	5	6	7	Units
0		> 0 - 0.5	0.51 - 1	1.1 – 1.5	1.6 - 2	> 2	%

28. Rate of loss of vegetation (REI): *Net percentage of land area changed by the removal of natural vegetation over the last 5 years.*(H).

Like No.22, this indicator is problematic due to its attempt to capture 'natural' vegetation. The practice of swidden agriculture - commonly known as 'slash and burn' - is no longer considered to be as damaging, long term, than was previously thought.

1	2	3	4	5	6	7	Units
			0	> 0 – 2.5	2.6 - 5	> 5	%

29. Tourists (REI): *Annual number of international tourists x average days stay / 365 / km^2 (over the last 5 years).* (M).

A proxy for 'the additional load of all human impacts not reported in population statistics' (Kaly and Pratt, 2000, 17) it will also incorporate aspects of No.18 'Potential for Introductions' although this is not noted by SOPAC.

As noted above, this indicator seems to assume that visitors have a lower impact upon the environment than inhabitants.

1	2	3	4	5	6	7	Units
0 – 10	11 - 20	21 - 30	31 – 40	41 - 60	61 - 80	> 80	No./d/km^2

30. Wastewaters (REI): *Litres / km^2 / days of untreated industrial and domestic wastewater discharged.*(H).

Requiring measurement by length of coast and rivers, it has been noted this would pose difficulties for island states like Jamaica where some rivers flow underground.

1	2	3	4	5	6	7	Units
0 – 1,000	1,001 – 2,000	2,001 – 3,000	3,001 – 4,000	4,001 – 6,000	6,001 – 9,000	> 9,000	L/km^2/ Day

31. Production of hazardous and municipal wastes (REI): *Total tonnage of generated and net imported toxic, hazardous and municipal wastes/ km^2 / year (average over last 5 years).* (M).

Debate over this indicator revolved around differences in toxicity of domestic and industrial waste.

1	2	3	4	5	6	7	Units
0 - 10	11 - 20	21 - 30	31 - 40	41 - 50	51 - 60	> 60	T/km^2/yr

32. Waste treatment (REI): *Mean percent of hazardous, toxic and municipal waste effectively managed or treated / year.* (L).

By referring to 'effective management' various strategies are included, such as composting, recycling, controlled incineration, as well as controlled landfill practices.

1	2	3	4	5	6	7	Units
81 - 100	61 - 80	41 - 60	21 - 40	11 - 20	5 - 10	< 5	%

33. Oil spills (REI): *Number of spills of oil and hazardous substances > 1,000 litres during last 5 years on land, in rivers or within territorial waters / land area (multiply results by 1,000).*(L).

Originally framed to only consider spills affecting coastal areas, this has been widened to include spills affecting the entirety of a country.

1	2	3	4	5	6	7	Units
0		> 0 – 0.5	0.51 - 1	1.1 – 1.5	1.6 - 2	> 2	No./km^2

34. Toxic industries (REI): *Number of nuclear, chemical and other major industrial facilities that could cause significant damage / 10,000 km^2 land area.* (L).

It was suggested at the Malta meeting that the denominator be extended to include territorial waters as well as land area. SOPAC have decided to include oil rigs in this indicator – the scenario that provoked the above suggestion – but retain the terrestrial denominator.

1	2	3	4	5	6	7	Units
0		> 0 –0.5	0.51 - 1	1.1 – 1.5	1.6 - 2	> 2	No./km^2

35. Vehicles (REI): *Number of vehicles / land area.*(M).

This indicator uses the World Bank definition of 'vehicle' as opposed to 'car' as in the original wording. Some consideration was given to using density of traffic on roads rather than total land area but this was discarded as indicating congestion rather than the ability of land to attenuate vehicular pollution.

1	2	3	4	5	6	7	Units
0 - 5	6 - 10	11 - 15	16 - 20	21 - 25	26 - 30	> 30	No./km^2

36. SO^2 concentration (REI): *Max. 24 hour SO^2 concentration (micro g / cubic m) (average last 5 years).* (M).

Now a requirement for global management, data for this indicator is completely lacking in those PICs involved with the EVI thus far (Fig 8). No levels have been set for this indicator as yet.

1	2	3	4	5	6	7	Units
							µg/m^3

37. Fertilisers (REI): *Tonnes of N, P, K fertilisers used / sq km agricultural land area / year (average last 5 years) (multiply result by 1,000).*(L).

This indicator is a proxy for eutrophication, pollution, soil damage and the loss of arable land. Rated 'Low' like the next indicator ('Pesticides') it seems to understate the 'downstream' effects on aquatic ecosystems such as lagoons.

1	2	3	4	5	6	7	Units
0 – 20	21 - 40	41 - 60	61 - 80	81 - 100	101-200	> 200	T/km^2/yr

38. Pesticides (REI): *Tonnes of pesticides used / sq km of agricultural land / year (average last 5 years) (multiply result by 1,000).* (L).

Like No.37 above, this is a proxy for pollution and soil damage; also damage to the reproductive systems of organisms.

1	2	3	4	5	6	7	Units
0 – 20	21 - 40	41 - 60	61 - 80	81 - 100	101 - 200	> 200	T/km^2/yr

39. Fisheries stocks (REI): *Number of new fisheries stocks or expanded fisheries efforts (>20% increase in catches) added to country over last 5 years (within territory).*(L).

Originally worded as 'new fisheries species' this was considered misleading by the Malta delegates, and the term 'stocks' was added. This indicator also attempts to capture 'added effort' or new technologies.

1	2	3	4	5	6	7	Units
0	> 0 - 1	1.1 - 2	2.1 - 5	5.1 - 8	8.1 - 10	> 10	No.

40. Degradation (EDI): *Percentage land area degraded since 1950 (includes salinisation, desertification etc).* (H)

This has been defined as the 'reduction or loss...of the biological or economic productivity and complexity' of land due to uses of that land or 'from a process or combination of processes' (Kaly and Pratt, 2000, 71). These processes can arise from human activities and settlement patterns, or the deterioration of the physical, chemical, biological or economic properties of soil, or the long-term loss of vegetation. The

definition is standard for Agenda 21 and the Convention to Combat Desertification but will still be difficult to measure.

1	2	3	4	5	6	7	Units
0	> 0 - 1	1.1 - 2	2.1 - 5	5.1 - 8	8.1 - 10	> 10	%

41. Water resources (EDI): *Mean rate of water usage per capita per day.* (H).

The rationale for measuring renewable water supply per capita is that lower availability per head would create higher pressures on natural ecosystems (i.e. water for people is considered to have a higher priority than for ecosystem conservation) The issue of water quality has also been covered by indicators 30, 33, 37 and 38.

1	2	3	4	5	6	7	Units
0 - 20	21 – 40	41 - 60	61 - 80	81 - 100	101 - 200	> 200	L/capita/day

42. Sub-surface mining (REI): *Tonnes of mining material (ore + tailings) extracted / sq km land area / year (average last 5 years).* (L).

The 'Low' weighting of this indicator ignores the extreme negative impacts of several mining operations in Melanesia.

1	2	3	4	5	6	7	Units
0 - 20	21 – 40	41 - 60	61 - 80	81 - 100	101 - 200	> 200	$T/km^2/yr$

43. Surface mining (EDI): *Percentage land, rivers, and coastal zone affected by mining and quarrying.* (L).

Originally including 'sea area', this was discarded following the Malta meeting; the term 'coastal zone' therefore requires more precision. By receiving a 'Low' weighting, the value of this indicator has been diluted for several islands in the Pacific, notably Nauru and Banaba, where phosphate mining has devastated much more than the 10% of land area that rates as a top 'score' for this indicator.

1	2	3	4	5	6	7	Units
0	> 0 - 1	1.1 - 2	2.1 - 5	5.1 - 8	8.1 - 10	> 10	%

44. Terrestrial reserves (EDI): *Percent of terrestrial zone set aside as reserves.* (M).

Originally a 'risk exposure' indicator, it is now an 'environmental degradation' proxy for the 'intactness' of the terrestrial environment, the presence of refugia, and the level of environmental management.

1	2	3	4	5	6	7	Units
> 20	11 - 20	6 - 10	1 - 5			0	%

45. Marine reserves (EDI): *Percent of marine zone set aside as reserves (mean high tide to continental shelf.* (L).

A proxy for the integrity of the marine environment, refugia, and the level of environmental management, marine reserves are considered to increase resilience. The definition of exactly what constitutes a reserve is problematic in the Pacific where successful schemes such as the Makogai 'reserve' in Fiji have incorporated harvesting administered by traditionally-framed authority (as described in Section 3.3.1). Also that such an indicator would receive a 'Low' weighting downgrades the importance of sustainable coastal use on small islands, particularly coral atolls.

1	2	3	4	5	6	7	Units
> 20	11 - 20	6 - 10	1 - 5			0	%

46. War/civil strife (EDI): *Number of war or civil strife years over the last 50 years within the territory.* (M).

This is intended to be a proxy for the lack of effective environmental management during periods of civil disorder as well as capturing the damage to the environment from physical manifestations of war, such as bombing, toxic chemical, military construction and vehicle disturbance. A difficult but unfortunately relevant indicator for some PICs who have suffered extreme impacts from the *preparations* for war, that is by weapons testing (including atmospheric nuclear tests) and the dumping or otherwise disposing of de-commissioned chemical weapons. In its current form this indicator is perhaps most valuable for the 'distraction' imposed by civil dysfunction.

1	2	3	4	5	6	7	Units
0	> 0 - 1	1.1 - 2	2.1 - 5	5.1 - 8	8.1 - 10	> 10	Years

47. Sanitation (EDI): *Percentage of population with access to safe sanitation (WHO).* (M).

A proxy for eutrophication and pollution. No levels have been set for this indicator yet.

The final EVI 'score' is to be calculated across all indicators irrespective of which sub-index they belong to. Recommendations were made at the Fiji meeting to combine the IRI and EDI into a 'Resilience' sub-index; this has apparently not been adopted by SOPAC who considered that it reduced 'the usefulness of the EVI sub-index information by unnecessarily pooling intrinsic and extrinsic risk' (Kaly and Pratt, 2000, 4).

5.5 The EVI 'Calculator'.

The actual calculation of the single figure EVI score is carried out using an EXCEL workbook. The workbook is comprised of seven linked worksheets, each dealing with the following aspects of the calculation:

1. Questions table: indicators and their categorisation.
2. Input screen: responses to indicators questions, and confidence in the data.
3. Response matrix: scoring results and weighting adjustments.
4. 'Help' file: definitions of terms.
5. Report Level 1: the highest level of reporting, where overall EVI and sub-indices are calculated
6. Report Level 2: breakdown of REI and EDI sub-indices, showing relative contribution of various categories of indicators.
7. Report Level 3: adjusted and 'raw' scores for each individual indicator.

A separate copy of the calculator is required for each country.

5.6 Data: capacity and availability

The main method for data collection in is the use of prepared data sheets, to be filled by respondents, with a whole page assigned for each indicator. Each response sheet contained five sections: i) the text of the indicator; ii) information for the respondent regarding what the indicator represents and possible data sources; iii) a formatted space for the respondent to enter the data; iv) space for comments by the respondent concerning the quality of data; and v) details about the respondent and stamp of authority verifying the data.

Data availability and relevance has been a major concern of various environmental organisations in the Pacific (UNEP, 1999). The lack of institutional resources and trained personnel in assessment and monitoring have been a constant problem with environmental management in the developing world in general, and SIDS in particular. In the course of developing the EVI, SOPAC has noted a number of concerns relating to this.

The first revolves around differences in the structure and functioning of PIC governments and their departments: similar agencies may have different responsibilities and consequently hold different data sets. Subsequently the identification of appropriate sources and collection of the necessary information has been complicated. As a result, costly 'in-country missions' and direct assistance to countries has been necessary to overcome these difficulties (Pratt *et al.*, 2001, 8).

The costs of data collection, analysis and storage for some countries have meant a tendency for cost recovery attempts to be made by government agencies for the time and actual data. Some data may be considered sensitive and thus be subject to limited access requiring special authorisation; government support for the EVI is instrumental in overcoming these instances (Pratt *et al.*, 2001, 9).

The collection and maintenance of environmental data sets in the Pacific has not always been accorded high priority. Some PICs have no comprehensive data sets for certain issues and for others the research is ad hoc and databases are incomplete. Various standards or methods have been used, leading to discrepancies between countries. Risks of inaccurate equipment and lack of quality control procedures may result in inaccurate data (Pratt *et al.*, 2001, 9).

Some of the data SOPAC require is accessed from other intergovernmental organisations such as the World Meterological Organisation (WMO), the Food and Agricultural Organsation (FAO) and ESCAP; interestingly, the CIA World Factbook has also been utilised (admittedly for 'highest altitude' for the uncomplicated indicator 13; Kaly and Pratt, 2000, 48). These organisations, with the possible exception of the CIA, base their data on statistics provided by member countries. Two main problems result from using these sources; the data provided often has important gaps, notably regarding small states, and some of the environmental data required for the EVI is not collected. It was argued however that international organisations could act as catalysts for data procurement (Briguglio *et al.*, 2000). Figure 8 shows which indicators have proven most difficult for SOPAC to collect, and which have been relatively easy.

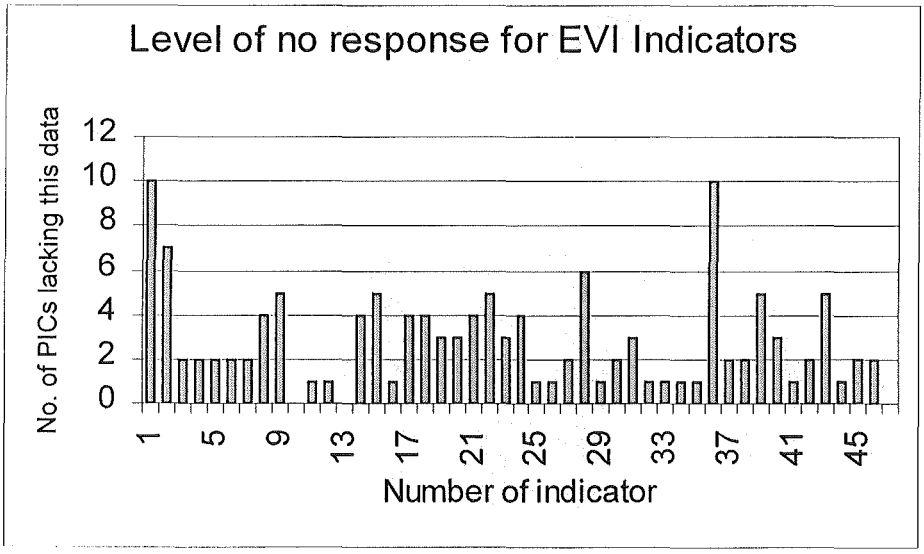

Fig. 8: Indicators for which no data was supplied for latest phase of EVI testing (Pratt *et al.*, 2001, 11)

In collecting data from other SIDS as part of Phase III, Barbados, Jamaica, Trinidad and Tobago, St Lucia, Malta and Mauritius, SOPAC have found the same problems hindering their progress (Pratt *et al.*, 2001, 10). For PICs, Kiribati, Tonga, Vanuatu, Niue, Nauru, FSM and PNG have all failed to reach the 80%, or 38 answered indicators, that are considered necessary for a valid EVI result. Only Palau has completed all of the 47 indicators (see Figure 9).

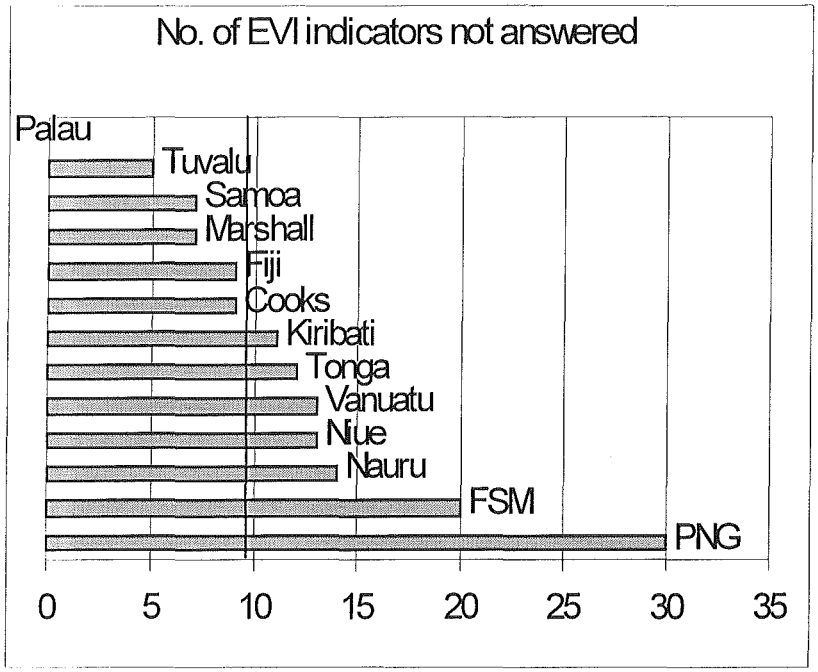

Fig. 9: The number of EVI indicators not answered in latest phase of development; line indicates requirement for valid EVI score, ie no more than 9 unanswered indicators). (Pratt *et al.*, 2001, 11).

5.7 EVI Funding.

As noted previously, New Zealand has been a significant funder and support of the EVI project through Phases I and II. The governments of Norway and Ireland have also made contributions. Phase III, in which the decision to 'globalise' the EVI was made, has for

the purposes of gaining the necessary funding, been divided into five modules, described as follows:

Module 1: The refinement and testing of the EVI, collecting data from 15 countries, the Malta Think Tank, publication in a peer-reviewed journal, continued testing. Costed at US$242,660, this Module was expected to take 12 months to complete.

Module 2: Pacific EVI capacity building. US$156,987; 9 months.

Module 3: development of the EVI computer interface. US$16,714; 2 months.

Module 4: development of sustainable data collection processes for the EVI, through in-country and international agencies. US$64,446; 3 months.

Module 5: 'validation' of the EVI. US$123,500; 6 months.

The total cost of Phase III has been calculated to be US$604,307 and will have a duration of two years (Kaly and Pratt, 2000, 61).

5.8 Conclusions.

Following their initial brief, SOPAC have engaged in a process of developing a methodology for the calculation of a difficult concept – environmental or ecological integrity – that has revolved around their core expertise of geoscience. In this SOPAC has been aided by New Zealand, especially in the first two phases of the project, not just with the necessary funding but also by a supporting stance in various regional and international meetings. This context sees a number of wider political priorities operating which compromise scientific research, which is reliant on financial and political support, by framing its aims and ultimate operation.

The involved process of selecting and defining indicators, as well as assigning them 'weights' and developing a methodology for quantifying heterogenous data has seen a

number of arbitrary and subjective decisions made. As a result of this, serious questions are raised as to both the 'accuracy' of such an index in measuring 'environmental vulnerability', and the value of this project for Pacific Island communities.

After originally framing this project as a Pacific regional initiative, it has since expanded in an attempt to be globally applicable, not just to other SIDS but to any country. Continued costs and the need to secure wide support have meant SOPAC is engaged in a large-scale endeavour to maintain support and secure further funding in order to complete their project.

Chapter Six: Critique of the EVI.

As Chapter 5 demonstrated, the process of constructing the Environmental Vulnerability Index involves decisions and procedures that have implications for the usefulness of that index as a tool. Defining what aspects of the environment are to be considered was the first major decision; the second was deciding what constitutes 'vulnerability' for that environment. This chapter will analyse SOPAC's decisions with regard to these two areas. It will also critically examine the basis and applicability of the EVI at the sub-national scale in the Pacific, that is to Pacific Island communities as opposed to Pacific Island Countries. In addition the issues of weighting, data, and funding will be discussed. The aim is to assess how well the EVI improves knowledge and communication on the state of the environment, how well it is able to do this over time, and how useful the EVI is for addressing the issue of contemporary environmental vulnerability for Pacific Island communities.

6.1 EVI operational definitions.

6.1.1 The Environment.

For the purposes of the EVI, SOPAC have defined the *natural environment* as 'those biophysical systems that are capable of being autonomously sustained without human inputs' (Kaly *et al.*, 1999b, 12). Demarcating a 'natural' environment from which humans can be 'removed' yet still considered an external risk factor is problematic. Of the 20 experts at the Fijian Think Tank, just over half were *against* what they considered the arbitrary exclusion of people (Kaly *et al.*, 1999b). Discussion at that meeting revolved around the exclusion of environmental changes on aspects of human existence, as well as how to quantify anthropogenic 'risk factors' (those human activities that impact in quantifiably 'negative' ways).

SOPAC's justification for not including the impacts of environmental change on humans occupation and many of the interactions with their environments was twofold. Firstly, their task, articulated in Paragraphs 113 and 114 of the Barbados Plan of Action of 1994,

was to attempt to quantify those physical characteristics of the environment described as 'ecological fragility' (cited in Kaly *et al.*, 1999a, 13). Second, SOPAC considered that human value is implicit in the EVI, and humans may be excluded as 'responders' because the selected indicators take into account the 'values that humans place on the environment' (Kaly and Pratt, 2000, 27).

As Chapters Two and Three have shown, the construction and use of environmental knowledge, and the associated 'values' with which that environment is imbued, are subjective - that is they are culturally and geographically shaped. It is not possible to measure environments objectively, so any attempt is therefore value-laden. Human knowledge reflects but does not correspond to the actual environment, although it is this 'real' environment upon which human action impacts and is in turn affected (Figure 3, p19).

The EVI does not set out to exhaustively measure all the dimensions of the environment, and SOPAC have stated, as an 'overriding principle', their desire to avoid the introduction of 'complexities into the model unless there was a justifiable reason to do so' (Kaly *et al.*, 1999a, 6). For the purposes of EVI, SOPAC have selected broad dimensions of the environment, such as temperature, biodiversity, toxicity, and have attempted to isolate, assess and measure relevant indicators of these dimensions (Kaly *et al.*1999a, 4). SOPAC refers variously to this environmental character as 'integrity' (Kaly *et al.*, 1999a, 4), 'fragility' (Pratt *et al.*, 2001, 3) 'quality' and 'health' (Pratt *et al.*, 2001, 13) using different terms for essentially the same thing.

The EVI proceeds from an assumption that the less degraded/more pristine the environment of a country (or other designated spatial unit), then the more human society 'benefits' from occupation of and/or interaction with that environment. However, positing any state like 'integrity' or 'quality' upon an environment that is discontinuous, and arbitrarily so, is to simplify the reality of the way ecosystems and human societies operate.

Assuming that the environment can then be meaningfully quantified is to further impose subjectivity while utilising a methodology that is portrayed as objective. The value of scientific insight for addressing environmental issues is widely accepted and has been regularly voiced by New Zealand representatives in support of the EVI at several international fora. In this context, the scientific credibility of the EVI is accepted at face value, continuing the discourse that the contribution of scientists is somehow more worthy than the contributions of non-scientists (Kiddle, 1999).

6.1.2 Environmental Vulnerability.

SOPAC defined 'vulnerability' for the purposes of the EVI as the 'proneness of the natural environment to damage and degradation', damage being considered 'the loss of diversity, extent, quality and function' of the environment, and degradation as 'irreversible damage' (Kaly *et al.*, 1999b, 34). These are measures of ecosystem complexity and interrelatedness which have featured in other indices, although not to the same extent as in the EVI.

As has been argued, 'concerns' regarding the environment will reflect culturally-grounded values. A primary concern for Western scientists and environmentalists is biodiversity, whereas for Pacific Islanders food security is the main issue. In the Pacific, environmental values have been rendered more problematic by social upheaval, both historical and contemporary, and the associated imposition of economic mechanisms that have dismantled previously holistic concepts of the environment, allowing the partitioning and commodification of Pacific Island resources, often though not necessarily by foreign interests. This means that no one set of problems will be unanimously accepted by individuals or groups with an interest in the Pacific region, but rather a range of problems will be interpreted for Pacific environments. As Sections 3.1.2 and 3.2 has shown, historically those groups with the most power have asserted their 'concerns' and imposed responses with their interaction with the Pacific environment.

Pacific Island communities have subjective criteria by which they judge the 'quality' or 'integrity' of their environments. Three implications follow from this. First, as was shown in Section 3.3.1, PIC societies exhibit strongly held cultural values that must be incorporated into any effective environmental management strategy. Secondly, as has also been demonstrated, Pacific Islanders may be unwilling to utilise their resources in a manner considered 'economically desirable' or 'necessary'. Most commonly this has been seen as ongoing problems with any development that attempts to ignore or requires extensive reform of traditional tenure systems.

Thirdly, Pacific Islanders may be willing to 'degrade' their environments, in various ways and for various reasons, that may run counter to other concepts such as those expressed as mainstream environmentalism, or considered aesthetically desirable for tourism. Many Pacific Island communities have expressed a desire to convert natural capital into financial capital, leading to the loss or damage of resources that are highly valued by Western-trained ecologists and many environmental groups. These factors reveal that Pacific Islanders can and do have conceptions of vulnerability at variance with the 'vulnerability' discourse articulated by SOPAC.

6.2 Limitations of the EVI Indicators.

A number of issues arise from the selection and wording of indicators. As most environmental change is not measured directly but by proxy variables, these proxies may capture factors not associated with the 'true' variable, and cumulative errors may arise if many such proxies are used. The availability of the relevant data is also an issue: do the data exist, and is the continued supply of this information assured for the benefit of longitudinal studies? These and other issues will be discussed for each of the five categories adopted by SOPAC in their framework.

6.2.1 Meteorological indicators.

The need for this category was questioned by several delegates at the Fiji meeting in September 1999. For instance Clarkson (1999, 59) argued that 'virtually everything climatic [is] normal from an environment viewpoint'. Clarkson went on to say that while meteorological events can devastate an environment, this is primarily a concern on the human time scale. As humans are supposedly excluded as 'responders' by this index, such a stance seems contradictory.

The weighting scale has decreed each of these indicators as 'Medium', yet they reflect acute concerns that many commentators hold for the Pacific Islands in general, and the atolls in particular. Cyclones (captured by Indicator No.2), and coral bleaching and in-shore marine fisheries (reflected in Indicator No.1) represent two important issues for the survival - both in the short and long term - of Pacific Island communities. For Pacific Islanders, these indicators are of 'High' importance.

The EVI considers a number of phenomena in similar terms, primarily frequency and magnitude but also duration and spatial extent. Use of the 1 to 7 scoring system allows a range of measurements to be standardised, capturing aspects of this variation in the physical dimensions of each indicator such as the percentage of an area affected, or the number of days a certain limit was exceeded. However, most indicators will also include a value above or below which a phenomenon is not considered to contribute to vulnerability for the purposes of the EVI. For example, 20% is the lower and upper limit for dry and wet periods respectively (Indicators No.3 and No.4). These are arbitrary limits: just one month of 20% variation in the past 5 years will rate a score of 1; 60 months of 19% variation will not be scored at all.

The reliance on a number of recording stations raises issues of data availability, not just for small and isolated islands but also the large islands of Melanesia with their complex topography and variable climates. Many Pacific Islands experience very different local climates from their leeward to windward sides, and these may not be captured due to inadequate recording facilities.

Concerns have been expressed over the physical preservation of monitoring stations. Some stations in the Pacific have been established for a considerable period of time, since 1902 in the case of the Apia station (Nukurangi, 2001). Meteorologists practising in the Pacific region have complained of the loss of unbroken series of temperature and rainfall measurements as equipment failure or the actual closing of many weather stations due to economic restructuring has occurred. Other records have been distorted due to the monitoring stations being moved even short distances (Nukurangi, 2001).

6.2.2 Geological indicators.

The need for the EVI to be both simultaneously cognisant of the human time scale and 'aloof' from the impacts on human systems seems contradictory with geological indicators too. Like meteorological events, geological phenomena are also 'natural' and claims that they have negative impacts are only relevant with reference to human activity.

With only three indicators, this category seems to be poorly represented in the index, although each indicator – Volcanoes, Earthquakes and Tsunamis - is a measure for events that can be of devastating impact on Pacific Islands. While reference to a 'geological timescale' normally implies temporal affects considerably beyond those applicable to a human life, these hazards can be of very rapid onset. Warning signals are evident for some events, particularly volcanic eruptions and far-field tsunamis. That these three indicators have been rated Medium (volcanoes), or Low (earthquakes and tsunamis) dilute the risks that PICs face from these events, any one of which, of sufficient magnitude, could obliterate a Pacific Island community, as was experienced by the West Sepik Province in Papua New Guinea, with a near-field tsunami 1997.

This category also suffers from the arbitrary use of limits to ignore phenomena that do not reach a certain magnitude. For example, volcanoes with an Explosivity Index score of less than 4 will not be included in the EVI, despite the volcanic history of many relatively small islands in the Pacific, any one of which could be severely affected by even 'minor' volcanic activity. The island of Taveuni, Fiji, has experienced a number of volcanic

eruptions in the past, with over 150 craters evident on 183 square-mile island. Previously thought to be extinct, recent research by geologist Dr. Shane Cronin has indicated this is not so, and volcanic activity is 'almost certain' to recur (Cronin, 1998). This indicator for Fiji scored a 1 in provisional testing (Kaly and Pratt, 2000, 27), with zero recorded volcanoes for the country (Kaly and Pratt, 2000, 47). Note however that Dr Cronin was working in conjunction with SOPAC during his fieldwork (SOPAC, 1998).

One of the more notable omissions from SOPAC's indicator list is any direct reference to accelerated sea-level rise. Although effects of a rise in sea-level rise are captured by proxy in indicators No.14 and No.15 (Lowlands and Coastal vulnerability respectively) no mention of this is made in SOPAC's latest EVI publication (Pratt *et al.*, 2001). This is a reflection of SOPAC's position that accelerated sea-level rise is not an immediate concern as other, more pressing problems, exist (Simpson, 2000; Howarth, 2000). While this position is supported by other regional experts (Nunn, 1999), concerns over the threats from a rising sea-level dominate the political platform that Small Island States utilise at a number of international fora. As SOPAC does not explicitly include sea-level rise, and actually dismisses many concerns held about what is still a contested phenomenon, SIDS may ultimately choose to promote indices and studies that highlight this politically powerful issue, and ignore or sideline any that do not and therefore marginalise the EVI.

The rationale for SOPAC's dismissal of sea-level rise is related to new research they have conducted that reveals many atolls in the Pacific are subject to seismic activity that increases the risk they face from tsunamis which they see as being more important than sea-level rise (Simpson, 2000). The EVI makes does not directly incorporate measures of this seismic activity other than the catastrophic events measured by indicators 7, 8 and 9.

Like weather stations, concerns exist for the viability and survival of monitoring stations that provide data for these indicators. Volcano monitoring equipment on Rabaul, Vanuatu, was vandalised in 2000. Described as a 'mindless act' by one official, the need

for cooperation and support by local inhabitants for governmental or other projects is illustrated by such actions (PIR, October 17, 2000)

6.2.3 Country Characteristics.

These indicators in many ways summarise the main characteristics of small island developing states that framed the original call by the Maltese Ambassador at the 1990 UNCTAD meeting, subsequently restated by AOSIS and articulated by paragraphs 113 and 114 of the 1994 Barbados Plan of Action (cited in Section 5.1). To restate: Small Island Developing States experience a range of problems stemming from their unique island characteristics: small size, isolation, and a relatively extensive coastal exposure. However, the 'contribution' that such indicators make to the EVI score of a small island state may subsequently be nullified by 'good' results, say in the lack of industrial facilities (indicator No.34) or industrial waste (No.31), or even in the lack of tourists (which would represent a failure of contemporary development policy).

The seven indicators in this category are intended to reflect or capture those aspects of a country that comprise its resilience, or ability 'to minimise or absorb the effects of damage' (Kaly *et al.*, 1999b, 12). This category correlates to the Intrinsic Resilience sub-index, and primarily measures physical characteristics on the basis that larger, less fragmented, less isolated countries (that is, those nearer to Australia for PICs), with higher topography will be less vulnerable. In addition, 'value' is added by a collection of diverse endemic species (indicator 16), the parameters of which are not described (see Section 6.2.4).

This poses a number of anomalies for the Pacific, of which the issue of sub-national applicability will be dealt with below (Section 6.3). One anomaly is that Pacific Islands that are *raised* coral atolls with comparatively little if any land area below 10 metres above sea-level (indicator No. 14), may receive a low 'score' in that measure. Storm surge has caused damage to Nuiean infrastructure 20 metres above sea-level, as noted by a SOPAC-authored paper (Solomon and Forbes, 1999). Some of these islands are among

the most isolated of the PICs, such as Nauru or Banaba, with no near neighbours, and will therefore suffer more from isolation than islands in an archipelago. And while these two examples will presumably score poorly with regard to mining indicators, will that one indicator (No. 43, surface mining) somehow 'make-up' for what was the defining economic activity in their modern history?

Another anomaly is evident with the Melanesian countries, particularly Papua New Guinea, the largest, most populous Pacific nation, and also the closest to Australia. To suggest that these characteristics are somehow reflect a resilience that Papua New Guineans can benefit from is to ignore the extreme insularity of many Highland communities - a factor of their physical isolation and an estrangement from one another that is a legacy of distrust and superstition - and the generally parasitic relationship with Australia, as shown by the mining industry.

6.2.4 Biological indicators.

While the EVI is an attempt to measure ecological integrity, previous efforts have included some form of productivity measure - the amount of biomass produced - or the number of linkages in a food web as a reflection of biodiversity (Haberl, 1997; Ulanowicz, 2000). In this respect SOPAC's interpretation of biological indicators seems at variance with much contemporary ecological work. There are models of ecosystem functioning that attempt to measure the productivity of collections of organisms which would satisfy SOPAC's position of excluding human responders, yet these have not informed this index.

The calculation method used in the EVI does not cater for feedback mechanisms or the synergy between one indicator to another. As this is one of the key characteristics of ecosystems, the EVI may not have credibility with ecologists and some environmental groups.

The problem of migratory species was raised in the discussion of indicator No.24 (Fisheries) and similar concerns exist for other species, particularly birds, that may rely on more than one country for their survival. The arbitrary demarcation of nation-states as imposed by colonial powers and retained for the majority of post-independence PICs not only ignored accepted indigenous boundaries but also, for the purposes of environmental management, phenomena that transcend these boundaries. The EVI as a country-focused measure fails to capture the transboundary nature of many environmental change problems.

Even a cursory examination of PIC agricultural history and modern practice reveals a number of important plant species that have enabled the resilience of Pacific Island communities. Two, the sweet potato (*Ipomea batatus*) and cassava (*Manihot esculenta)* came from South America; others such as the banana (*Musa sapientum)* and taro (*Cyrtosperma esculenta)*, originated in Southeast Asia and were disseminated by peoples as they colonised the Pacific region. (Thomas, 1999). The EVI excludes these particular species from the final score by only including species introduced since 1900. In effect this arbitrary date establishes a baseline for this indicator.

The problem is repeated for several other indicators such as No.21, Extinctions, and No.9, Tsunamis. However, other indicators have different historical baselines, eg No.40, Degradation of land since 1950, or 'moving' baselines such as 'over the last 50 years' for No.46, War/civil strife.

The problematic aspects of one pathogen, dengue fever, have been mentioned under indicator No.17, 'Pathogens and plagues'. It has been acknowledged that inter-country comparisons for many outbreaks of pathogens are significantly affected by different reporting systems, making this yet another indicator for which valid data will be hard to come by (WPRO, 2000). Also successful mitigation of the mosquito vector for dengue fever has been achieved with the application of *Bacillus thuringiensis*, a naturally occurring bacterium (although one increasingly the subject of genetic engineering) that is utilised as an organic biocontrol (WPRO, 2000). These and other biological agents

arguably would be 'registered' under 'Introductions' and so would register negatively in the EVI even though their role is to mitigate the negative effects of other species. SOPAC's model lacks the ability to make subtle distinctions such as this.

6.2.5 Anthropogenic indicators.

This is the largest category with 23 indicators, and also the most problematic. The reasons for this revolve around the definition of what a 'natural environment' is, and the role of humans within this environment. To recap, humans have been excluded as 'responders' in the EVI as SOPAC are attempting to examine 'only' the 'natural environment'. SOPAC's position is that the selected indicators take into account the 'values that humans place on the environment' (Kaly and Pratt, 2000, 27). However, the *effects* of human activity are still included as the EVI is intended to measure environmental 'integrity', a condition that has been eroded by the cumulative effects of various human activities.

Various anomalies exist, for instance on how the EVI should treat croplands. One delegate at the Fiji meeting gave the following scenario: while it is unproblematic to consider a field of sugar cane as reducing the resilience provided by natural vegetation, how would the EVI rate the subsequent replacement of the sugar crop with, say, corn? Would this add to or reduce vulnerability? (Osborn, 1999, 69).

Another anomaly is the EVI treatment of population. Tourists, presumably foreign, who visit small islands (as encouraged by contemporary development strategy) are weighted as less important for environmental vulnerability than are indigenous residents. The subtext of this is 'lots of indigenous people, bad; lots of tourists, not so bad' (actually quite good, as economic indices would undoubtedly record). This is not to say that population pressures do not exist in the Pacific. On some PICs such as Tuvalu where density per square kilometre approaches 300, or Nauru where it is around 400, the issue is acknowledged as serious and worsening (Connell, 1984). However, the negative environmental effects that accrue to these islands are the result of a lack of infrastructure to deal with the effects, a lack of effective regulation, or an inability to enforce such

legislation where it does exist. This describes a much more complex situation than SOPAC have allowed for in their vulnerability model.

Harvey (1974, 274) argued that whenever a theory of overpopulation is accepted in a society controlled by an elite, 'the non-elite invariably experience some form of political, economic and social repression'. On some PICs oppressive policies are already evident in a number of areas, such as the freedom of the media, the activities of opposition parties, and development projects that are dismissive of local concerns and the rights of landowners (see Finin and Wesley-Smith, 2001).

It is difficult to ignore SOPACs position with regard to people in the EVI model. Although it ostensibly deals with a 'natural' environment shorn of human 'responders', it is difficult not to view this index, in part at least, as implicitly measuring the inhabitants of designated environment while not taking account of the concerns or values they hold.

6.2.6 Calculation of the EVI.

The EVI is subject to arbitrary weighting, refined in consultation with experts at the Malta meeting, although still not finalised (Pratt *et al.*, 2001). Different weighting schemes would lead to different results, as occurred with the provisional testing of the model on Fiji, Samoa, and Tuvalu and Vanuatu (Kaly and Pratt, 2000). A single index figure is 'counter-productive' if it does not reflect 'current values of the local or global community' (Osborn, 1999, 71).

Further, by averaging and summarising data, important variations may be hidden, for example when a positive score for one indicator cancels out a negative score for another. A collection of experts, especially if from disparate fields but even if belonging to the same discipline, would perhaps decide upon a very different weighting scheme. The EVI will be open to such criticisms.

6.3 The Sub-national Scale: islands and islanders.

SOPAC claims the EVI will be applicable to sub-national areas, most obviously individual islands but it is also considered applicable to even smaller scales such as adjacent bays (Craig Pratt, pers. comm.). Within the Pacific, where many states are archipelagos, often of considerable territorial extent, such an application would have considerable value.

As mentioned in Section 6.2.3, all the Intrinsic Resilience indicators are broad-based proxies for the resilience of a *country* (Kaly *et al.*, 1999b, 13). The capacity for fulfilling the data requirements for the EVI do not yet exist for the more peripheral islands in the Pacific region, will develop only slowly, and may never provide comprehensive data for all Pacific Islands.

Advances in remote sensing technologies may alleviate some of these problems, allowing measurements of remote areas and islands for some indicators, and more accurate measures for other variables. However, the need for co-operation by local inhabitants for the sustained collection of data from isolated islands raises the issue of reliability and bias.

6.4 Motivations for the EVI.

The primary motivation for the development of the EVI was to incorporate a countries environmental characteristics with its economic features to assist in the determination of Less Developed Country status and other aid allocations (Section 4.4.2). These are *political* aims and it has been acknowledged by SOPAC that some countries are interested in the results of the EVI because the index could help them support their claim for special status and increased aid (Pratt *et al.*, 2001). Considering that it is intended for environmental aid to be tied to high or increasing vulnerability scores, the temptation to

'fudge' scores for higher allocations may ultimately nullify the value of the index for monitoring the long term state of environments in the developing world. These are places that are most at risk from environmental degradation.

The decision to globalise application of the EVI is justified in terms of the assumed universal applicability of Western science: underlying physical phenomena are not 'suspended' from operating in certain parts of the planet, and science that has proven valid in one place is theoretically equally valid in another. However, there are now acknowledged regional differences in these processes and their effects, particularly with regard to climate change (Watson *et al.*, 1998). Coupled with the different cultural and geographic variations, universal applicability for a model dealing with a concept as subjective as 'vulnerability' is problematic.

The need for continued funding, which has of necessity been sought from foreign providers, raises questions over PIC influence and benefit. The contributions of many Pacific governments to their regional commitments are often slow in being paid (see for instance SPREP, 2000). Despite regular claims by SOPAC that the Pacific region some how has 'ownership' of this initiative regional support may wane as progress is predicated on the support of other nations.

The EVI process and model make no attempt to ascertain the 'concerns and values' that Pacific Island communities hold for their environments. Instead it has revolved around the perspectives of scientific and political communities. Many of the indicators selected by SOPAC may be considered irrelevant by Pacific Island communities; others may be considered of overriding importance. There may even be others not included in the 47 indicators that Pacific Islanders living on isolated islands consider of paramount importance in the viability of their island homes, for instance the high levels of radioactivity that have been recorded in the Marshall Islands (Crocombe, 2001). Yet these opinions and the people that hold them have no input or influence into the process of developing the framework or methodology of the EVI project.

6.5 Data: availability and reliability.

The lack of reliable data for effective environmental management has been a continual problem for policy and decision makers in the Pacific Islands (UNEP, 1999). As mentioned in Section 2.4.2, the construction of an index will necessarily be constrained by the availability of relevant data, and this has proven to be the case in the development of the EVI (Pratt *et al.*, 2001). This is ironic, considering two of SOPAC's programmes - Geographic Information Systems and Remote Sensing (GIS/RS), and the Wide Area Geographic Information System (WAGIS) - are primarily data collection and analysis programmes. The EVI's data problems points to SOPAC's limited expertise in the area of ecological modelling as opposed to geoscience.

There is a lack of coordination with SOPAC in other areas of data collection. For example the lack of acknowledgement accorded to work by Cronin (1998) with regard to volcanoes on Taveuni, Fiji, seems strange, given that his research was in Fiji, the 'home country' of SOPAC, and he was acting in conjunction with SOPAC.

The seriousness of these three phenomena - the potential reduction in official maintenance and support, the absence of local and unofficial support, and a lack of coordination among data sets and experts - cannot be understated in the Pacific region. Valuable data may be lost or compromised as a result of lack of support, whether from foreign funders, national governments or community acceptance. As the EVI revolves around the collection of data, and requires increasing contributions of data from PICs for valid results (fulfilling the requirement of 80% of indicators answered), these are serious concerns. For credible comparisons over time, continued and secure 'supplies' of these data are necessary, yet remain uncertain. The lack of capacity that governmental and non-governmental environmental organisations possess in the Pacific region mean that problems such as these are more serious than in other more developed and/or less isolated regions.

6.6 Conclusions.

The EVI project has attempted to delineate a 'natural' environment from explicit human use, so the resulting model posits a discontinuous, arbitrary environment at odds with ecological and anthropogenic functioning. It further advances a rigid definition of vulnerability that is assumed to be objective, from which proceeds a process of selecting, defining and weighting variables to quantify this concept. This process has been demonstrated to ignore or dilute a range of factors about which Pacific Island communities might reasonably be concerned.

Applicability of this index to sub-national measurements is compromised by the framework and methodology of the model itself. The capacity to fulfill the requirements for data relevant to the EVI does not exist at the national level, l*et al*one the local scale where it would be most valuable. This capacity is unlikely to be developed in the near future. Cooperation by relevant local authorities is likely to be predicated on perceived economic and political benefits over the short term, rather than environmental benefits over the mid to long term.

The motivation for the construction of this index has come from the broader collective of island states. The aim of assessing and communicating the environmental aspects of the constraints that these countries experience in their attempts at development have originated has certain prima facie justifications: these countries are small and isolated, and are surrounded by ocean. As a result they are subject to certain natural disasters, of which tropical cyclones are the most relevant and accelerated sea-level rise potentially the most disastrous in the long term, and certainly an emotionally charged issue in the current context. If the index fails to further advance the argument that Small Island Developing States are in need of 'special' attention with respect to aid, trade and other assistance, then the project is unlikely to enjoy further support from that quarter.

Many of the criticisms that could be levelled at the EVI occur in the compilation of indices and quantitative estimations in general. Accusations that such programmes are doing nothing more than 'measuring a metaphor' are difficult to avoid when the origin is political, the rhetoric all-encompassing, and the construction subjective. The relevance of a single figure, to one decimal place, that is intended to 'communicate' environmental vulnerability has limited relevance for Pacific Island communities.

Chapter Seven: Conclusions.

This thesis has examined a range of factors that lie behind the conception, assessment and monitoring of environmental vulnerability in the Pacific region. It has described the broad historical context of scientific and political mechanisms for managing the environment in the Pacific region. From this foundation, this thesis critically examined the process and construction of SOPAC's EVI, which is intended to address the issue of environmental vulnerability faced by contemporary Pacific Island communities. The thesis has illustrated many of the problems associated with this process. These will be summarised below, allowing the concept of vulnerability as it pertains to the Pacific region to be revisited. The chapter will finish with conclusions on the EVI model and recommendations for future research.

7.1 Summary

7.1.1 Science

Chapter 2 outlined the development of Western science and the role that environmental science has in addressing environmental issues. Beginning with the revolutionary change in intellectual thinking of the Enlightenment, it became obligatory to apply rigorous analysis to virtually every research field, and to each new area of investigation as it arose. Such intellectual ideals were carried in the minds of a succession of explorers and scientists around the world, including the Pacific, a region which has featured in a number of scientific advances.

Pacific peoples also have their own body of knowledge as a result of widespread and successful settlement, and the need for the continuation of viable communities. This body of indigenous knowledge, like Western science, is an integral component of the culture of its participants. However, it is Western science that is the cornerstone of environmental management in the Pacific region where it engages and informs concerns via a multitude of organisations.

Two main roles for environmental science are apparent for policy makers and environmental managers. Firstly it makes a certain amount of prediction possible, although this is subject to considerable uncertainty in many areas. The need for continued research into climate and other environmental changes, particularly in the tropics, has been acknowledged. Much also remains to be understood about atmospheric and ocean processes, and these gaps add to the uncertainty that island populations everywhere experience. Secondly science is called upon to disentangle anthropogenic influences from natural processes. This has important implications for the development of policy, although there appears to be a reluctance to implement sustainable development policies for fear that they might reduce short term economic growth.

Advances in environmental science in the post-World War Two period have forced a radical cross-sectoral re-evaluation of policies in the Pacific, in the process subjecting traditional institutions and modern organisations to challenges and threats as well as opportunities and benefits. It remains for this science/policy interaction to fully address the concerns held by Pacific Islanders for their environment.

7.1.2 Traditional practices.

Section 3.1.1 described how traditional Pacific Island communities generally practiced the sustainable use of their resources. The familiarity that traditional societies had with their environments enabled the accumulated and collective micro-scale knowledge of the environment to be transferred into pragmatic decision-making. This was enabled and informed by dynamic social institutions at every step of the process, from the allocation of tenure, through accepted methods and permissible seasons, to the distribution and enjoyment of benefits.

The community response to resource-poor locations or times of scarcity was generally to enact more detailed and restrictive access, the rationale for which was the maintenance of stable and harmonious communities by equitable sharing. A further response was to physically leave the islands and to establish a settlement on another island for short or longer periods of time. Both of these strategies were evident in coping with hazards and disasters. While the role of traditional institutions in managing environmental issues has

been altered in modern times, they have not been eradicated in the Pacific and remain an essential component of contemporary management. As Sahlins (2000, 51) has said, 'tradition is not the opposite of change'.

7.1.3 Post-contact.

The form and functioning of traditional Pacific institutions was to be fully tested by the intrusion of European colonial powers. Instigating rapid and irreversible social change, colonial interests imposed the commodification of resources for the benefit of colonial and other commercial interests, much of which was brokered through an indigenous elite.

Two phenomena feature in contemporary coping strategies. The first is large-scale and wide-ranging migration which has not necessarily diluted the practice of communal ownership, although it has constrained cooperation and development attempts. As a corollary to this, the role of remittances from an international network of kinship in the viability of contemporary Pacific Island communities remains vital. The second important feature of the Pacific region is the place of aid and other external support for governance, the formation and implementation of policy, the development and maintenance of infrastructure, and responses to environmental problems. Concerns over the level and effectiveness of this aid have led to demands for greater accountability and a more accurate focus in disbursing what are, per capita, relatively large amounts of funding.

The corresponding modern response to 'scarcity' in PICs – simplistically described as the lack of economic development - has too often been the unsustainable use of resources with the encouragement and support of neo-liberal policy, the largely non-Pacific promoters of which are not threatened by the effects of imminent environmental collapse. Individuals and groups across the Pacific region find themselves caught by a complex web of obligations and responsibilities in which effective management of the environment is compromised.

7.1.4 Multinational Organisations.

The legacy of colonial rule and the establishment of multilateral cooperation in the post-World War II era has seen the proliferation of organisations that have varying roles in the management of Pacific environments. This thesis has been concerned with those aspects of this phenomenon that influence the interaction of science and policy in the area of environmental vulnerability. What it has illustrated is that while the Pacific region is a beneficiary of the activity of these organisations, this relationship is not informed by the needs and wants of Pacific Island communities.

Advances in both the science and policy arenas have meant a number of global, regional and national strategies addressing environmental concerns have been implemented and to varying degrees enforced. Difficulties remain in tailoring these policies so that they have relevance and results at the local level.

While global environmental issues are readily promoted, regional scale issues remain of prime importance. The role of science in addressing these issues, coupled with its costs, has meant the Pacific region has relied heavily on external support as local capacity has proven difficult to develop and maintain. Programmes which attempt to build Pacific capacity in this area so as to better inform environmental management must justify their methods and aims. This is to make transparent the benefits of the gains in knowledge that too often in the past have accrued to external players or indigenous elites.

SOPACs development of an index intended to measure environmental vulnerability has originated from and been a beneficiary of the collective global attention that has focused on environmental problems associated with development in the developing world. This 'attention' has necessarily enforced certain requirements for its use by policy makers, in particular the simplification of scientific assessments. Yet as this thesis has demonstrated, such simplification hides a multitude of complexities that ultimately compromises the value of the EVI.

Can modern environmental organisations in the Pacific function as evolved forms of traditionally-focused institutions, which are cognisant of the particularity of Pacific

islands and the needs and wants of the people occupying them? If so, on what do they base their claims to legitimacy and jurisdiction? These are questions that scientific communities are poorly placed to answer, yet their activities and outputs are intimately associated with precisely these concerns.

7.2 Vulnerability Revisited.

Initial European discourse described the Pacific Islanders as 'noble savages' and their island homes as wondrous 'Gardens of Eden'. Assumptions of European racial superiority were also asserted, often violently so, and wholesale changes were imposed on indigenous societies. The environmental 'vulnerability' of Pacific Islanders in this context was not, in many respects, considered their 'fault'. Rather it was in the same vein as an 'act of God', no more than a heathen's lot, a legacy of the ignorance that only contact with, and ultimately control by, Europeans could hope to dispel.

More enlightened observers challenged this discourse as the empirical evidence of European contact with Pacific Islanders – the epidemics, rapid environmental change, slavery (however limited) and violent conflict (again, however limited) – undermined the legitimacy of external control. However, independence, when and where it was achieved, has not led to the satisfaction of indigenous demands, nor has the environment been accorded the priority that is increasingly warranted in the Pacific region.

Benefits from this contact are readily acknowledged by many Pacific Islanders, most of who are committed Christians and the recipients of long-standing, externally-sourced assistance in various forms. Yet the linkages of control remain, and resentment has arisen as development is seen to be a problematic phenomenon in which the interests of indigenous Pacific peoples come second to those of external powers and domestic elites. The very viability of their island homes is now threatened, and Pacific Islanders are increasingly demanding action from those interests with the resources to mitigate this vulnerability.

Attempts to partition ecological interrelationships from societal interaction are required to state where the boundary, arbitrary as it may be, is drawn. In the context of the developing world, linkages between the vulnerability of communities and the ecological integrity of their immediate environment are closer than would be observed in the developed world. For island communities, these are likely to be even 'tighter'.

Those features of an environment considered by SOPAC to indicate vulnerability operate at several levels and degrees of complexity. They are also contingent on different temporal scales, from geological periods and rapid onset disasters, to seasonal variations within biological and anthropogenic measures.

The assessment and monitoring of PIC environmental criteria sees a fundamental reliance on micro-scale data in which indigenous knowledge and local co-operation must have a role. The reasons for this are twofold. Firstly the provision of accurate and meaningful data can, in the context of Pacific Island environments, only be assured with the involvement of local inhabitants. Secondly, any programme or policy that is implemented with outside assistance will only attain legitimacy with the involvement of locals.

SOPAC's original brief was for a measure of the 'natural' environment, and the indicators that have been selected are not intended to measure human-system vulnerability in an effort to avoid repeating information that other existing indices already measure. These other indices originated with economic measures such as growth in GDP, and later incorporated proxies for 'quality of life' such as life expectancy, infant mortality and literacy. In many respects they measure the results of political and economic decisions. What remains, theoretically, are those aspects of the 'physical' or 'natural' surroundings of the Pacific Islands that can survive without any human input, yet can still impact negatively on human society.

However, as this thesis has shown, despite intentions to the contrary, the Environmental Vulnerability Index is inescapably a tool for examining people and their interaction with their environment. Undoubtedly its development will have benefits for Pacific nations, such as enhancing the capacity to manage environmental change, raising awareness of

important or potential problems, and empowering PICs and their island allies in debates with more powerful and differently vulnerable nations. However, it is predicated on notions of environmental 'quality' and 'integrity' that are not necessarily acknowledged or accepted by Pacific Islanders.

The process of developing the EVI has seen SOPAC necessarily undertake a subjective approach by the selection and definition of proxies for environmental change. SOPAC has also operated within an administrative and bureaucratic arena that has meant engaging with, and being dependent on, various scientific and political groups as well as a range of individuals. This process has always been global and, like the relevance and weighting of the individual indicators, suffers from a lack of input from Pacific Island communities.

A critical analysis of the EVI has revealed a number of anomalies that compromise the model as a realistic portrayal of the Pacific environment, and as a useful tool for addressing concerns held for that environment. In the attempt to produce a single figure score of environmental vulnerability, the need for simplification has overridden the need for comprehensive relevance.

7.3 Review and Recommendations.

This thesis set out to examine the conception of environmental vulnerability in the Pacific, and the institutional responses to this vulnerability. It accepted the need for a broader appreciation of the historical and contemporary aspects of two wide fields, namely science and politics. This has proven difficult to achieve, and the complexities of the region have required generalisations, ironically of the sort that must be criticised as a conclusion to the exercise.

The environments and inhabitants of the Pacific Islands exhibit an incredibly diverse range of interactions, and any attempt to understand these phenomena at a regional scale must beware of floundering among the differences and yet avoid methods that simplify

and 'explain away' these differences. In advancing the EVI project, SOPAC place themselves in the position of those graduates of the Enlightenment, the 'travellers, virtuosi, and scientists' who were instructed to 'observe carefully, record accurately, and to experiment' (Smith, 1985, 1). As the activity of a science community, it has utilised an assumed objectivity that elevates their observations of the Pacific, and consequently inherits the mantle of those who first acted out this role in the 17th and 18th centuries.

While the scientific methodology - revolutionary when it was first formulated and refined - has changed little in over three centuries, the technology with which it interacts has been continually evolving. This has meant a constantly shifting foundation for the physical observation of the natural world. The need for baselines to allow the measurement of *change* in the environment requires accurate and sustained data collection, a process which is itself subject to change, sometimes of a revolutionary nature. SOPAC themselves are engaged in the continuum of science and technology. The problems they have experienced in collecting the required data for the EVI is a reflection of the lack of capacity that PICs have for Western scientific research, but it is also a reflection of the problems in deciding exactly what knowledge, information and hence 'data' is relevant.

As the EVI project shows, PICs and their regional organisations have profitably allied themselves with other island states for the purposes of articulating common concerns at various international fora. However, the index is likely to be of little utility for the purpose of allocating economic resources. Subnational complexities and institutional constraints will limit any attempts to precisely target environmental aid. 'Transgressions' of prescribed best practice in the area of environmental management may well result in an increase in assessed Environmental Vulnerability that will increase their claims for concessions from foreign powers.

The continued insertion of First World interests via theoretical assumptions and selective resourcing contributes to the fragmentation of indigenous control of their environments that is already present and increasing, and may further threaten State and foreign authority in the area of environmental management at the expense of local control. But

integration into the global system, with its myriad of organisations, programmes and funding, does not necessarily result in greater input into processes associated with the phenomenon (or phenomena) of 'globalisation'. While Western-trained scientists may have come along way from measuring non-European physiognomy and recording sexual practices, the requirement that the citizens of the developing world be 'fitted' within simplistic modelling remains.

Future research that has as its goal the mitigation of environmental vulnerability experienced by Pacific Islanders must first address what constitutes environmental 'integrity' for Pacific Islanders. What aspects of the environment do Pacific Islanders themselves wish to preserve? To better inform the relevant policy makers, research must also investigate how Pacific Islanders would like to see that achieved, and what policies they would like to see being implemented at the local level. 'Coping' is traditional, the mechanisms by which this is achieved are undergoing constant evolution.

Methods must be found and developed that recognise the validity of qualitative data, and means found of expressing results that do not seek simplicity at the expense of credibility. Finally, it is vital Pacific Islanders are more fully involved at every step of the process.

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